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SOME BYGONE OPERATIONS IN SURGERY.

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X. A CASE OF STRANGULATED UMBILICAL HERNIA. QUEEN CAROLINE OF ANSPACH.

(Concluded.)

"ON Sunday morning about nine o'clock, the surgeons upon opening the Queen's wound found the mortification was not spread; and upon cutting off what was already mortified, declared that she might recover. This appeared so inconsistent with their declarations some few hours before, and in my opinion showed so much ignorance, that if a life of this consequence committed to the care of four of the best physicians and three of the best surgeons in England received no better assistance from their skill, how natural it is to deplore the situation of those whose safety depends on the sagacity of these professions and how reasonable to despise those who put their trust in such aids. Not that I am so unjust to surgery as to put that science upon the same foot with physic; and, for my own part, I firmly believe that there was not the least mortification begun, when they ignorantly pronounced there was; and that what they cut off was not mortified and only declared so to conceal the mistake they had made the night before in saying it was.

"Monday and Tuesday the Queen was what the doctors, surgeons and courtiers called better, there being no threatening symptoms in her wound and her vomitings being much slackened; but nothing passing through her those who judged by essential circumstances, and not on the hourly variation of trifles whatever they might say from fashion or to please, could not in reality believe the Queen's condition more hopeful or less dangerous whilst that main point of the internal stoppage continued in the same situation; and whenever the King used to tell her how much better the doctors and surgeons said she was and the hope they gave him, the moment his back was turned she used to look at the Princesses, shake her head and bid them not flatter themselves and often in the day used to tell them, 'Believe me, my dear children, it won't do; at twenty-five I might have struggled through it, but at fifty-five I cannot resist.'

"On Thursday the Queen's vomitings returned with as much violence as ever and in the afternoon one of the guts burst in such a manner that all her excrement came out of the wound in her belly, though the surgeons could not by any probing certainly tell whereabouts in the gut the fracture was. The running at the wound was in such immense quantities that it went all through the quilts of the bed and flowed all over the floor.

"Some ignorant people about her who knew not from what cause this evacuation proceeded told the Queen they hoped the relief would do her good, to which the Queen replied very calmly, she hoped so too for that it was all the evacuations she should ever have.

"Every day once, at least, and sometimes oftener from the first of her being under the surgeons' hands they were forced, or thought themselves so, to make some new incision; and before every operation of this kind which she underwent, she always used to ask the King if he approved what the surgeons proposed to do; and when he said they had told him it was necessary and that he hoped she would consent to anything they thought so she always submitted immediately and with the utmost patience, resignation and resolution suffered them to cut and probe as deep and as long as they thought fit. She asked Ranby once, whilst he was dressing her wound, if he would not be glad to be officiating in the same manner to his own old cross wife that he hated so much; and if any involuntary groans or complainings broke from her during the operations, she used immediately after to bid the surgeons not mind her, and would make them apologies for interrupting them with her silly complaints when she knew they were doing all they could to help her.

"From the time of the bursting of the gut the physicians and surgeons who had hitherto, without any disguise or reserve, talked over all the particulars of the Queen's case to anybody that asked them any questions were absolutely forbidden by the King to reveal this circumstance or to give any other answer for the future to anybody whatever who inquired concerning the Queen's health than the general one of her being much as she was.

"During this time the King talked perpetually to Lord Hervey, the physicians and surgeons and his children of the Queen's good qualities, his fondness for her, his anxiety for her welfare and the irreparable loss her death would be to him, yet so unaccountable were the sudden sallies of his temper and so little was he able or willing to command them that in the midst of all this flow of tenderness he hardly ever went into her room that he did not snub her for something or other she said or did. When her constant uneasiness from the sickness in her stomach and the soreness of her wound made her shift her posture every minute, he would say to her; 'How the devil should you sleep when you will never lie still a moment? You want to rest and the doctors tell you nothing can do you so much good and yet you are always moving about. Nobody can sleep in that manner, and that is always your way; you never take the proper method to get what you want and then you wonder you have it not.' Notwithstanding the constant pain she was in and her great want of rest the physicians never gave her opium but one night. She herself was not much inclined to take it and the physicians, thinking that it might possibly, from its binding quality, prevent the relief she so much wanted were not very forward to prescribe it. She had not

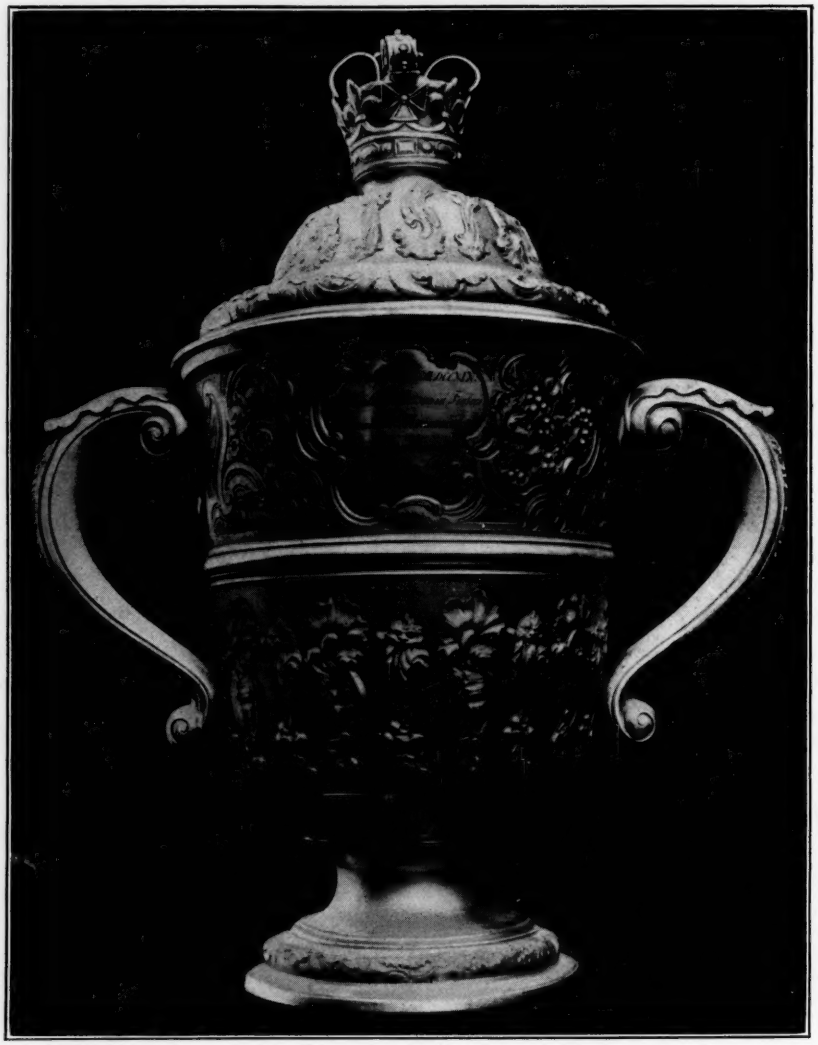
rested with it all night and when the King came into her room in the morning as she lay with her eyes fixed at a point in the air, as people often do in those situations when they are neither enough at ease to shut their eyes and sleep or to see the things they seem to look at, the King with a loud quick voice said to her; 'Mon Dieu! qu'est ce que vous regardez? Comment peut-on fixer ses yeux comme ça? Vos yeux ressemblent à ceux d'un veau à qui on vient de couper la gorge!'

"The Queen grew so perceptibly weaker every hour that every one she lived was more than was expected. She asked Dr. Tessier on Sunday the 20th. November in the evening with no seeming impatience under any article of her present circumstances but their duration, how long he thought it was possible for all this to last. To which he answered; 'Je crois que votre Majesté sera bientôt soulagée.' And she calmly replied, 'Tant mieux.' About ten o'clock on Sunday night (Nov. 20th. 1737) the King being in bed and asleep on the floor at the feet of the Queen's bed and the Princess Emily in a couch-bed in a corner of the room, the Queen began to rattle in her throat and Mrs. Purcel giving the alarm that she was expiring, all in the room started up. Princess Caroline was sent for and Lord Hervey but before the last arrived the Queen was just dead. All she said before she died was; 'I have now got an asthma. Open the window.' Then she said; 'Pray.' Upon which Princess Emily began to read some prayers, of which she scarcely repeated ten words before the Queen expired. The Princess Caroline held a looking-glass to her lips and finding there was not the least damp upon it, cried; ''Tis over'; and said not one word more nor shed as yet one tear on the arrival of a misfortune the dread of which had cost her so many.

"The King went to his own side and as soon as he was in bed sent for Lord Hervey to come and sit by him, where, after talking for some time and more calmly than one could have expected, of the manner of the Queen's death, he dismissed Lord Hervey and sent for one of his pages to sit up in his room all night, which order he repeated for several days afterwards. And, by the bye, as he ordered one of them for some time after the death of the Queen to lie in his room and that I am very sure he believed many stories of ghosts and witches and apparitions, I take this order to have been the result of the same way of thinking that makes many weak minds fancy themselves more secure from supernatural danger in the light than in the dark and in company than alone."

John Ranby (1703–73) who operated upon the Queen, was appointed Surgeon in Ordinary to the King's Household in 1738 and Serjeant Surgeon in 1740. He was a Londoner by birth and was apprenticed to Edward Bernard. Like his master, he was a 'foreign brother' of the United Company of Barbers and Surgeons and never held office. When the United Company was dissolved in 1745 he was elected the first Master of the Surgeon's Company, serving a second time in 1751. In memory of his first Mastership he presented the Surgeons' Company with the loving cup which is now in the possession of the Royal College of Surgeons of England. By the kind permission of the President and Council, it is here represented. It is a standing cup of silver with a cover and measures 15½ in. in height and 7½ in. diameter at the rim. The inscription runs:—

Die Julii primo MDCCXLV
Hoc qualecunque suae in Fratres
Observantiæ Monumentum
Dignissimæ Chirurgorum
Londinensium Societati
Consecrat Joannes Ranby



which may be translated, "John Ranby dedicates this memorial, such as it is, to the very worshipful Company of Surgeons on the first day of July, 1745, as a token of regard for his brethren." The armorial bearings on the side of the cup opposite the inscription appear to be a later addition, for they were not granted until 1822. It is probable, therefore, that they were engraved in that year when the new Charter gave the College a Mace and the right to call itself The Royal College of Surgeons of England. The hall-mark shows

that the cup was made in London, 1745, and the maker's mark, E. G. with a full stop above and below in a lozenge, that it was produced by Elizabeth Godfrey.

Ranby owned land at Fulbrook, Ealing, jointly with Henry Fielding, the novelist, who mentions him in *Tom Jones*. He succeeded William Cheselden as Surgeon to the Royal Hospital at Chelsea. His appointment is dated May 13, 1752. He died there on Aug. 28, 1773, and is buried under a plain altar tomb on the north side of the burial ground. Ranby married in 1729 Jane, elder daughter of the Honourable Dacre Barrett-Leonard, but had no children by her. His natural son, John Osborne (1743–1820), took the name of John Ranby in 1756.

Ranby is described as a man of strong passions, coarse voice, and vulgar manners. His chief work was *The Method of Treating Gunshot Wounds*, a small 12mo which appeared in 1744, a second edition being published in 1750, and a third in 1781. It gives an account of some of the cases he saw when he was serving under Lord Stair in the German campaign which ended with the battle of Dettingen in 1743, where he had the Duke of Cumberland as a patient. It is written in an extremely simple style and foreshadows that associated aid for the wounded which has only lately been adopted.

The two physicians called Tessier and Broxholme by Lord Hervey were Physicians to St. George's Hospital, then newly founded as an offshoot from Westminster Hospital.

George Lewis Teissier was a foreigner who graduated at Leyden in 1710, and, as his estate was administered by his sister living at Zell, he was probably a German by birth. He was appointed Physician to the Household of King George I in 1710, and attended several members of the family of George II. He lived in Pall Mall and died there unmarried on May 22, 1742. Mr. George C. Peachey has shown that he owed much to Sir Hans Sloane.

Noel Broxolme was born at Oakham, Rutlandshire, in 1686, was admitted a King's Scholar at Westminster School in 1700, and matriculated as a Junior Student from Christ Church, Oxford, in 1704. He was elected the first Radcliffe Travelling Fellow in 1715. Whilst he was living in Paris a grateful patient gave him £500 stock in the Mississippi Scheme which he sold shortly afterwards for £10,000. He practised for some years in Oxford, and in 1730 married the wealthy widow of William Dowdeswell, of Pull Court, Worcestershire. He was elected Physician to St. George's Hospital in 1733, and in the following year was appointed Physician to Frederic, Prince of Wales. Horace Walpole, writing to George Montagu under the date July 25, 1748, says: "You have seen in the papers that Dr. Broxholme is dead. He cut his throat. He always was nervous and vapoured and so good-natured that he left off his practice from not being able to bear seeing so many melancholy objects. I remember him with as much wit as ever I knew; there was a pretty correspondence of Latin odes that passed between him and Hodges." He had no children by his wife, who survived him with his two stepsons. He lived in Albemarle Street but died at Isleworth in July, 1748.

The Portrait of Queen Caroline that appeared in the last issue is copied from that in the National Portrait Gallery, painted by Enoch Seeman (1674–1744).

CALCAREOUS DEPOSITS IN THE SUPRASPINATUS TENDON.

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THE occurrence in X-ray photographs of the shoulder of shadows situated over the top of the great tuberosity was first recognized by Painter,[1] and thought by him to be due to thickening in the subdeltoid bursa. In four cases in which such shadows were present and which he explored by operation he found in two a cheesy material having the appearance of the contents of a wen which he thought was contained in the subdeltoid bursa. But Codman,[2] who was present at one of these operations, stated that this material was not in, but deep to, the bursa. According to him a small opening was made into the bursa sufficient to admit the forefinger; the interior was not abnormal except for some firm adhesions which made it difficult to separate the plane of the bursa from the neighbourhood of the bicipital groove and anterior part of the great tuberosity. With the finger in this opening it was found that during rotation of the humerus a mass corresponding to the X-ray shadow could be felt to pass under the finger. This mass lay on the great tuberosity. An incision into it allowed the escape of about half a drachm of material resembling the contents of a dermoid cyst. Codman stated that he had seen another case in which there was calcareous material in the same situation and that he was familiar with the appearance in X-rays.

The subdeltoid, or subacromial, bursa is mentioned in Quain's *Anatomy* without description. Cunningham describes it as "a bursal sac as large as a hen's egg which is sometimes divided into loculi." From personal observation I should describe it as a tissue space lying in areolar tissue, some strands of which cross the cavity and may divide it into different compartments. It appears, however, to have no definite lining, and it has not shown any sign of being inflamed in any of the cases described below except *Case* 7, in which the deltoid muscle was adherent to the great tuberosity.

'Subdeltoid bursitis' has been very extensively discussed by Codman, who quotes many other varieties apart from the two cases in which calcareous matter was found. He believes that partial rupture of the supraspinatus tendon is a common lesion and that the calcareous formation may result from an insertion fracture of this tendon. Since Codman's description many cases of this calcareous deposit have been recognized and described. Brickner[3] has published a very thorough description based on a series of seven operations.

CASE REPORTS.

The following cases have come personally under my care :—

Case 1.—A woman, age 35, had had a pain in the left shoulder six or seven years previously which had never completely cleared up, so that she was unable to

play golf comfortably. She then wrenched the shoulder badly while playing cricket. It was very painful, was treated by electrical stimulation of the muscles, and improved in muscle power; but the pain continued. When first seen about four months after the onset of acute symptoms the pain was very severe. Very little abduction was permitted, but rotation of the joint was fairly good. There was a tender spot over the region of the great tuberosity. An X-ray showed a characteristic shadow in this situation. Operation was discussed, but as the patient was at the time five months pregnant it was decided to postpone this. However, three weeks later the pain was so severe that the patient demanded operation. An incision was made along the anterior border of the deltoid, the muscle was lifted back, and the region of the great tuberosity exposed. An evident inflammatory swelling was found adherent to the bone and was dissected away, including part of the attachment of the supraspinatus tendon. The pain was relieved immediately; the wound healed without complication. Physical treatment was started five weeks after operation and recovery of function was fairly rapid.

FIG. 69.—*Case* 2. X-ray showing the diffuse shadow above the great tuberosity.

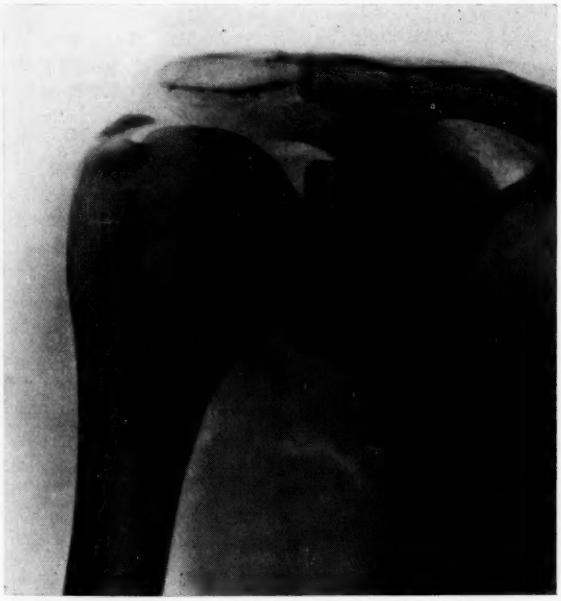

FIG. 70.—*Case* 3. The calcareous matter forms a more solid-looking mass which might be taken for a loose piece of bone.

Case 2.—A woman of 32 had a history of only three weeks' pain in the right shoulder which was ascribed to a strain whilst playing tennis, but the pain was present before this occurred. An X-ray had been taken and the diagnosis of fracture made. Operation was carried out as in the previous case, the inflamed area being completely excised. Function was fairly good in two months, but not complete until four months after operation. (*Fig.* 69.)

Case 3.—A man, age 50, had a fall on the shoulder fifteen years previously, and from that time onwards had some rheumatic pain in the right shoulder. In the autumn of 1929 he fell from his horse, injured his back, and made the shoulder a little

painful. He spent the next day shooting, and the pain then became very acute so that morphia was required for the next week, at the end of which time an operation was performed. On the top of the great tuberosity was a yellow patch about ¾ in. in diameter with an acutely inflamed area extending around it. This yellow patch was lifted entire from the humerus and removed. Beneath it a small opening into the bone was discovered from which calcareous granules were curetted. The wound healed satisfactorily, physical treatment was started on the eleventh day, and function was fairly good at the end of two months. (*Fig.* 70.)

Case 4.—A woman, age 34, had a fall from her horse twelve years previously, injuring the right shoulder, which had never completely recovered. Seven years after this she had a severe attack of pain which necessitated complete rest, and from that time the shoulder was always painful when the arm was lifted. A fresh acute attack of pain necessitating the administration of morphia occurred a week before the patient was seen. At the operation the condition seen was very similar to that in *Case* 3, and there was a similar cavity in the humerus. Massage was started after operation, and the restoration of function was rapid. (*Fig.* 71.)

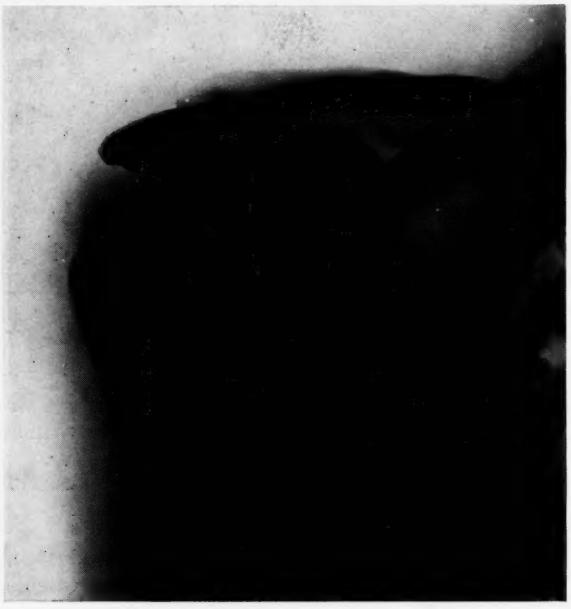

FIG. 71.—*Case* 4. The shadow is slight and partially hidden by the humerus. It might easily be missed.

Case 5.—A woman, age 50, strained the right shoulder five years previously in reaching upwards. From that time on there was always a certain amount of pain. Two months before she was seen she had a sudden severe pain in the shoulder which was sufficiently bad to prevent her sleeping. An X-ray photograph, taken at the time of onset of the acute pain, showed a characteristic shadow of large size. Another, taken two months later, showed the patch considerably smaller. At the operation the top of the great tuberosity was not obviously inflamed, the calcareous patch was only found by incising into it. It was then removed entire with a portion of the supraspinatus tendon down to the bone. The calcareous matter was dried up and surrounded by fibrous tissue. There was no cavity in the bone.

Case 6.—A woman strained her right shoulder five years previously. One year later the arm was again injured by being pulled severely. For the last year the shoulder has been chronically painful. Her movements were full and only painful at one point during elevation. There was a tender spot over the great tuberosity. An X-ray showed a characteristic shadow, and the shoulder was explored. The appearance seen was similar to that in *Case* 5. In this case there was considerable pain after operation and functional recovery was very slow, but the after-care was not carried out under my direction.

Case 7.—A woman, age 40, first began to get pain in the right shoulder eighteen months previously as a result of playing the violin. There was no definite injury. The pain gradually became worse so that she was obliged to give up playing. The movements of the shoulder-joint were fairly good, abduction being free up to the right angle, external rotation quite free, but internal rotation less than in the left

shoulder. There was a tender spot over the great tuberosity, and raising the arm in forward flexion produced the most pain. An X-ray showed a large irregular calcified patch over the great tuberosity. It appeared to be situated rather far back. At the operation an incision was made along the front of the deltoid, and on retracting the muscle backwards it was found to be adherent to the great tuberosity over an area about an inch in diameter. When it was retracted this area was found to be rather prominent and slightly yellow in colour. An elliptical incision was made around it down to the bone, and everything peeled off the bone from before backwards. A small cavity containing inspissated calcareous material was opened because it communicated with a tiny cavity in the bone. In the upper part some fibres of the supraspinatus tendon were seen and removed, but the tendon was not completely divided and the shoulder-joint was not opened. The cavity in the bone was about $\frac{1}{4}$ in. in diameter and $\frac{1}{4}$ in. deep. It was curetted with a small gouge. Recovery was rapid. Physical treatment was started at the end of a fortnight, and movements were practically complete two months after the operation.

Case 8.—In the following case the X-ray appearance was not typical and there is some doubt about the diagnosis. A man, age 55, strained his right arm heaving a kit-bag into a dinghy. The joint was strapped for a fortnight and he then had some physical treatment, but the shoulder did not get right. Two months later the joint was examined under an anæsthetic and no adhesions were found. When seen four months after the original injury he had a painful spot on the great tuberosity, a limitation of all movements to about half their ordinary range, and pain on active abduction. X rays showed an irregularity at the top of the great tuberosity with a doubtful shadow above it. Operation was suggested, but, as the diagnosis was not quite certain and the symptoms were not severe, it was decided to try physical treatment first. The shoulder was treated by Dr. Morton Smart by manipulation and by electrical methods. It improved rapidly, so that four months later the patient was able to carry a gun and use the arm freely, although he still had some aching pain. Another X-ray, taken six months after treatment started, still showed some irregularity on the top of the great tuberosity. Since then the arm has greatly improved. The patient now states that he has free movement but that he cannot take liberties with the shoulder. He has tried to play tennis, but cannot do so. He can do half a day's shooting, but a whole day leaves his arm tired. Recovery is therefore good but not quite complete.

These cases occur in adults of all ages. They can be divided into those which are acute and those which are chronic with acute exacerbation. Injury has not occurred in every case and is often not very definite, but it seems clear that trauma lights up the condition in a case of old standing. In the acute cases the pain may be very severe. In *Cases* 1, 3, and 4 it necessitated the use of morphia continuously.

Amongst the clinical signs the occurrence of a tender spot on the top of the great tuberosity appears to me to be very characteristic, although Brickner in his cases found that it might be absent. Movement may be little restricted in the chronic cases, but when the condition is acute there is much muscular spasm and the arm may be held quite rigid. The X-ray appearance is very characteristic. The shadow may be taken for a loose body in the shoulder-joint. This was so in a case described below. But it is usually situated too far out to be in the joint and, as one radiologist pointed out, there may be a change of shape of the shadow in different positions, suggesting that there is a sac containing opaque fluid rather than a solid piece of bone. It is easy to miss the shadow in some positions of the shoulder because it may lie behind a part of the humerus. In some cases a patch of rarefaction in the great tuberosity may suggest that there is a cavity such as was found in *Cases* 3, 4, and 7.

Case 8 recovered without operation, but the X-ray appearance was such as to make it a little doubtful whether the diagnosis was correct. Such recovery, however, occurred also in the case of a medical man who suffered from the condition and in whom the diagnosis of a loose body in the shoulder-joint was made. The shoulder was explored by another surgeon, but of course no loose body was found. This patient now writes :—

> The only cause I can think of for the trouble was that I rushed up a narrow staircase in the dark, fell forward, and threw out my arm in front to save myself. A few days afterwards the pain was very intense and the only relief came from raising my arm above my head or placing the palm on my occiput. I did not go to bed for about a week, resting for most of the time on a couch. I lost about one and a half stone in weight in a fortnight. G. diagnosed 'myositis ossificans of the deltoid'. X rays showed a foreign body in the shoulder-joint. Nothing found on exploration. G. B., who assisted at the operation, said there was myositis ossificans of the supraspinatus tendon at its insertion in the head of the humerus. Pain after operation continued for a fortnight, but the arm gradually got all right. I still get a good deal of pain at times and there is a lot of grating in the joint and some limitation of movement backwards.

The original X-ray showed a large diffuse shadow over the great tuberosity.

Experience seems to show that removal of the calcareous matter gives the quickest relief from pain in the acute cases and the most satisfactory cure in the chronic cases. The best route is that along the anterior border of the deltoid, as this does not interfere with subsequent function of the muscle.

In the acute cases the appearance seen is very characteristic, with a central yellow patch looking like a thin-walled abscess and obviously inflamed tissue all around. In the chronic cases there is little to be seen wrong, and it may only be possible to identify the exact site of the calcareous matter by an incision into it in the line of the supraspinatous tendon (*Case* 5).

The pathological lesion may be dealt with either by excising it completely down to the bone or by opening and curetting. I have preferred the former as the more thorough procedure. It necessitates opening the shoulder-joint in many cases, but this does not seem to interfere with subsequent recovery. The bone beneath the insertion of the tendon should be examined to make sure that it does not contain a small cavity. I have preferred the incision along the anterior border of the deltoid, lifting this muscle backwards. The approach is a little easier if the incision is made farther back and the deltoid split, but if this is done there is a small risk of interfering with the nerve-supply of the anterior part of the deltoid muscle.

In none of the cases have I found any tear in the supraspinatus tendon or any necrotic tissue.

Pathology.—The material removed was examined histologically in five of the cases. In *Case* 1 (*Fig.* 72), which was very acute, the central cavity contained blood. In its margin lay the calcareous matter, which was non-crystalline and was embedded in masses of inflammatory cells amongst which were a few giant cells resembling those seen in the neighbourhood of a foreign body. Around this central cavity lay fibrous tissue in various stages of development containing acutely inflamed patches, in some of which more

calcareous particles were present. On one side of the central cavity beyond this inflammatory area there was a layer of tendon tissue. In *Case* 2 the appearances were almost identical.

In *Case* 3 (*Fig.* 73) the central cavity was surrounded by a layer of fibrous tissue, the inflammatory tissue lying external to this. In *Case* 4 the central cavity was full of calcareous matter and débris. Around it was a very cellular inflammatory tissue and beyond this on the superficial aspect a definite layer of tendon. On the deep aspect some fragments of bone and cartilage

FIG. 72.—*Case* 1. Section of the margin of the cavity showing the calcareous matter darkly stained, some of which lies in the cavity, some in inflammatory and fibrous tissue around.

FIG. 73.—*Case* 3. Section of the margin of the cyst showing tendinous tissue in the edge of the cavity and inflammatory tissue around with calcareous material both in the cavity and in the inflammatory tissue.

represented a point at which the tendon had been lifted from the great tuberosity with the sharp rugine. In *Case* 6, which was of a more chronic nature, there was no very definite central cavity, the calcareous matter lying embedded in fibrous tissue which did not show any of the evidences of acute inflammation seen in the other sections.

Professor Kettle has looked over these sections, and agrees that they show the changes that would be expected in an acute or chronic inflammation around calcareous matter acting as a foreign body. There is nothing in them to suggest necrosis occurring in the tissues.

Cultures taken at the operations were all sterile, and none of the sections suggests a tuberculous infection. The calcareous material obtained from the first case was examined by Dr. McKenzie Wallis, who found it to consist of calcium stearate. Analyses have been reported by Painter, who states that the 'ash' contained a small amount of sulphate of potash and 90 per cent calcium carbonate and calcium phosphate; and by Brickner, who found chiefly calcium oxalate.

As these observations seemed to be at variance with one another the material obtained from *Case* 7 was carefully investigated by Dr. G. A. Harrison, with the following results :—

Chemical Examination of Cyst Contents.—The cyst contents were white and cheesy in appearance with hard gritty lumps in suspension.

Qualitative tests revealed a small proportion of organic matter (presumably protein mainly). The ash consisted largely of calcium phosphate, but there was also a small amount of carbonate.

Quantitative examination gave the following results :—

Matter soluble in ether : nil.

Matter soluble in hot amyl alcohol : nil.

Matter soluble in ether after acid hydrolysis = 7 mgrm. This gave no reaction for cholesterol. The amount was too small for identification. In view of the fact that hot amyl alcohol extracted nothing, calcium soaps were absent.

The dry weight of cyst contents examined (approximately half) = 231·7 mgrm.

Weight of ash = 162 mgrm.

Weight of calcium (as Ca) = 51 mgrm.

Weight of inorganic phosphorus (as P) = 23 mgrm.

Calculated Results.—Assuming that all the phosphorus was present as $Ca_3(PO_4)_2$, and the residual calcium was combined as carbonate, the following are obtained by calculation :—

Calcium phosphate	=	116 mgrm.
Calcium carbonate	=	15 mgrm.
Undetermined ash	=	31 mgrm.
Total ash	=	162 mgrm.

The nature of these calcium deposits is still uncertain. Nothing similar has been described elsewhere in the body, so it would appear that some local anatomical lesion is responsible for their occurrence. The most obvious suggestion is that of a tear of the insertion of the supraspinatus with a resulting effusion of blood and of some fatty tissue from the interior of the cancellous spaces, that calcification occurs in this, and that the calcareous matter then acts as an irritant foreign body.

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[1] PAINTER, *Boston Med. and Surg. Jour.*, 1907, clvi, 345.
[2] CODMAN, *Ibid.*, 1908, clix, Oct. 22 and following numbers ; 1911, clxv, 115.
[3] BRICKNER, *Amer. Jour. Med. Sci.*, 1915, cxlix, 351.

AN ANALYSIS OF THE MORTALITY IN ACUTE APPENDICITIS WITH RESPECT TO DRAINAGE AND THE VARIETY OF OPERATION.

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ABERDEEN UNIVERSITY.

During the period January, 1911 to June, 1923 (twelve and a half years), accurate notes are found of 632 cases of acute appendicitis operated on in Sir John Marnoch's ward in the Aberdeen Royal Infirmary. From June, 1923, to December, 1929 (five and a half years), 781 consecutive cases were operated on from the ward allotted to Mr. Colt. From the total number (1413) five cases in which the details are insufficient have been excluded from

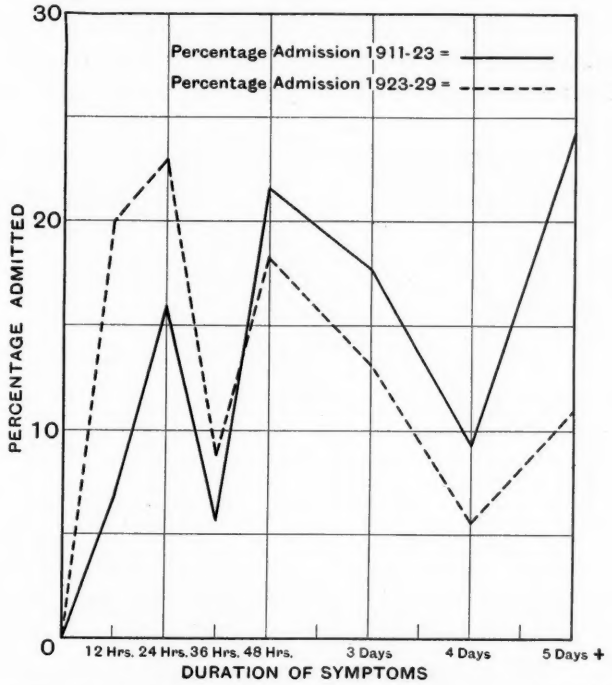

Fig. 74.—Graph showing the percentage admission in 1911–23 as compared with that in 1923–29 with regard to duration of symptoms.

Table I. Two cases of death during anæsthesia have been totally excluded. Owing to the subject of acute appendicitis becoming better known, the 1923–29 cases were on the whole sent in earlier then those for 1911–23, as shown

in the graph (*Fig.* 74), which gives the percentage admission with respect to duration of symptoms.

Table I.—Acute Appendicitis. Numbers of Cases Drained and Not Drained, 1911–29.

Condition of Appendix	Drainage	No. of Cases	No. of Deaths	Mortality
				Per Cent
'Acute with lymph', including 'pus in lumen' and 'gangrene of mucous membrane'	Yes	73	3	4·11
	No	615	9	1·46
Gangrenous not perforated	Yes	119	9	7·56
	No	134	3	2·24
Gangrenous perforated	Yes	105	6	5·71
	No	28	0	0·00
All cases, including abscess and general peritonitis	Yes	609	65	10·67
	No	799	13	1·63

From time to time statistics are published tending to support the advantage of non-drainage of the peritoneal cavity in the various stages of the disease. The figures in *Table I* show the numbers of cases drained and not

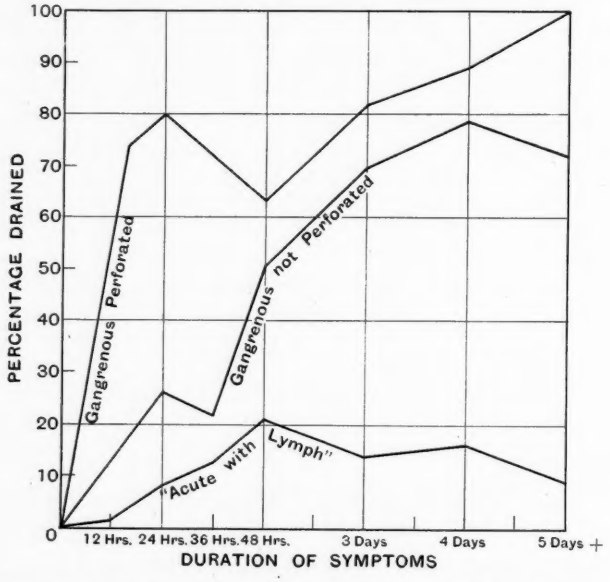

Fig. 75.—Percentages drained and duration of symptoms. (Abscess, general peritonitis, and 'duration not recorded' cases excluded.)

drained, and the corresponding rates of mortality for the period 1911–29. A superficial consideration of the table lends support to those who prefer to

dispense with drainage. A closer inspection, however, shows that such support is not warranted, and it is apparent that any such collection of heterogeneous data is not capable of mathematical analysis. While the material was being arranged it became evident that in general the worse the case the more frequently was drainage employed. This comes out clearly in *Table II* and *Fig.* 75. The table also shows that only a small proportion of 'acute with lymph' cases are drained as compared with the 'gangrenous perforated'.

Tables II.—Percentage of Cases Drained and the Mortality in the Different Conditions of the Appendix Found at Operation, Classified according to the Duration of Symptoms.

Duration of Symptoms	'Acute with Lymph', including 'Pus in Lumen' and 'Gangrene of Mucous Membrane'			Gangrenous Not Perforated			Gangrenous Perforated		
	Drained	Not Drained	Per Cent Drained	Drained	Not Drained	Per Cent Drained	Drained	Not Drained	Per Cent Drained
12 hours	3	156	1·89	2	14	12·50	6	2	75·00
24 hours	15	160	8·57	16	44	26·67	12	3	80·00
36 hours	7	47	12·96	5	18	21·74	10	4	71·43
48 hours	24	92	20·69	32	32	50·00	20	12	62·50
3 days	9	54	14·29	36	16	69·23	22	5	81·48
4 days	7	37	15·91	11	3	78·57	16	2	88·89
5 days+	6	60	9·09	13	5	72·22	18	0	100·00
Totals	71	606	10·69	115	132	46·56	104	28	78·79

Table III.—Percentage Mortality at Different Periods of the Disease.*

	12 Hours	24 Hours	36 Hours	48 Hours	3 Days	4 Days	5 Days +	All Cases
Number of cases ..	183	250	91	212	142	76	102	1056
Deaths	1	4	2	4	9	3	7	30
Per cent mortality ..	0·51	1·60	2·20	1·88	6·34	3·95	6·86	2·84

* Abscess, general peritonitis, and 'duration of symptoms not recorded' cases have been excluded.

In the course of classification into more special categories, cases of various degrees of severity were seen to fall into the same class. For instance, it may happen that a patient with fulminating obstructive appendicitis in which the whole appendix has become completely gangrenous in seven hours, as occurred in a recent case, falls into the same group as a relatively mild case of obstructive gangrenous appendicitis with symptoms of the same duration. Again, when peritonitis appears, the extent of it is almost impossible to estimate with any degree of accuracy. Turbid fluid may be sterile, or it may contain organisms of great virulence, and, even when judgement is exercised

in the matter of drainage, chance plays a large part. In fact, only if preference were exercised in cases of apparently the same degree of severity, so that one was drained and the next was not, would the resulting data be of any value. This is a condition which clearly cannot be caried out in practice. It would appear that any opinion or impression that is advanced on the question of drainage is a purely personal one and cannot be supported mathematically until much more exact data are available.

When, however, we come to consider the results in the light of the method of approach to the septic focus, the old surgical rule of employing a short and simple route is found to be justified. *Table IV* shows that, during the years 1911–23, the mortality with the McBurney incision was greater than that with the Battle at practically all stages of the disease. The number of cases operated on through the paracentral incision during this period is unfortunately too small for convenient comparison when the cases are classified according to duration of symptoms. *Table V*, however, gives a fair comparison between the Battle and paracentral incisions, the mortality with the paracentral being greater throughout the series.

Table VI shows the differences in the percentage mortality for the Battle, McBurney, and paracentral incisions, and their statistical interpretation. From these figures it is clear that the Battle incision is preferable. During

Table IV.—Acute Appendicitis, 1911–23. Percentage Mortality

Duration of symptoms	12 Hours			24 Hours			36 Hours			48 Hours		
	Number	Died	Per Cent M.	Number	Died	Per Cent M.	Number	Died	Per Cent M.	Number	Died	Per Cent M.
Battle	21	—	—	44	—	—	23	—	—	50	2	4·00
McBurney	16	—	—	42	3	7·14	6	—	—	54	4	7·41
Paracentral	2	—	—	4	—	—	2	—	—	13	3	23·08
	Not included—46 cases with 2 deaths where there was no record of incision;											

Table V.—Acute Appendicitis, 1923–29. Percentage Mortality

Duration of symptoms	12 Hours			24 Hours			36 Hours			48 Hours		
	Number	Died	Per Cent M.	Number	Died	Per Cent M.	Number	Died	Per Cent M.	Number	Died	Per Cent M.
Battle	20	—	—	30	—	—	18	—	—	36	—	—
Paracentral	133	3	2·26	148	4	2·70	49	2	4·08	105	7	6·67
	Not included—10 cases where there											

* Fourteen days' history, general peritonitis

the period 1911–23, the chances were 18 to 1 in favour of the Battle as against the paracentral incision, but this mathematically is only 'possibly significant'. From 1923–29, however, the chances, 123 to 1, are found to be definitely in favour of the Battle incision. Again, over the whole period 1911–29 the mortality with Battle's incision was significantly less. It is of interest to note that in the 1923–29 series the diminution in mortality by the paracentral route has not kept pace with that by the Battle method, although practised 4·40 times as often, and about equally by the two surgeons concerned in the second series.

Mathematically considered, an error arises because it cannot be said that the various incisions are altogether randomly employed. Individual preference is exercised, and in course of time practice improves the handling of a case by one particular route. In spite of this, the chances in favour of the Battle incision are so great that this incision should be borne in mind in practice and in teaching by surgeons wedded to the paracentral route.

The low mortality for the Battle incision throughout the whole of the second series is striking. Had not a fourteen-day case with general peritonitis been operated on through this incision, the mortality would have been nil in the 179 cases. With the paracentral incision there is a distinct risk of spreading infection. Visible pus may be packed off, but no one can be sure of packing off

ACCORDING TO DURATION OF SYMPTOMS AND INCISIONS USED.

3 Days			4 Days			5 Days +			No Record Duration			Totals		
Number	Died	Per Cent M.	Number	Died	Per Cent M	Number	Died	Per Cent M.	Number	Died	Per Cent M.	Total	Died	Per Cent M.
34	2	5·88	26	2	7·69	52	4	7·69	9	1	11·12	259	11	4·25
54	5	9·26	21	—	—	45	6	13·34	12	—	—	250	18	7·20
11	1	9·09	5	1	20·00	26	1	3·85	5	1	20·00	68	7	10·29
8 cases with 1 death where another incision was used.												577	36	6·24

ACCORDING TO DURATION OF SYMPTOMS AND INCISIONS USED.

3 Days			4 Days			5 Days +			No Record Duration			Totals		
Number	Died	Per Cent M.	Number	Died	Per Cent M.	Number	Died	Per Cent M.	Number	Died	Per Cent M.	Totals	Died	Per Cent M.
21	—	—	4	—	—	15	1*	6·67	—	—	—	144	1	0·69
83	11	13·25	39	4	10·26	69	7	10·14	2	—	—	628	38	6·05
was no record of incision.												772	39	5·05

at operation, appendix not removed.

Table VI.—Acute Appendicitis. Statistical Comparison Between the Incisions Used.*

	Date	Incisions	Cases	Deaths	Per Centage Mortality	Difference in Per-centage ($p_1 - p_2$)	Standard Error of Difference (E)	$\frac{p_1 - p_2}{E}$	Chances	Mathematical Significance
Battle *v.* Paracentral	1911–23	Battle	259	11	4·25	6·04	3·11	1·94	18 to 1 in favour of Battle	Possibly significant
		Paracentral	68	7	10·29					
	1923–29†	Battle	144	1	0·69	5·36	2·02	2·65	123 to 1 in favour of Battle	Significant
		Paracentral	628	38	6·05					
	1911–29	Battle	403	12	2·98	3·49	1·39	2·51	82 to 1 in favour of Battle	Significant
		Paracentral	696	45	6·47					
Battle *v.* McBurney	1911–23	Battle	259	11	4·25	2·95	3·63	1·44	5·7 to 1 in favour of Battle	Not significant
		McBurney	250	18	7·20					
McBurney *v.* Paracentral	1911–23	McBurney	250	18	7·20	3·09	3·68	0·84	1·5 to 1 in favour of McBurney	Not significant
		Paracentral	68	7	10·29					

* Since *Table VI* was compiled the figures for 1930 and 1931 have been worked out (*Table VII*). They fully support the previous work.
† In the series 1923–29 the McBurney incision was not used.

Table VII.—Statistical Comparison between Battle and Paracentral Incisions when the Figures for 1930 and 1931, now Available, are Added.

	Date	Incision Used	Cases	Deaths	Per-centage Mortality	$\frac{P_1 - P_2}{E}$	Chances	Significance
Battle *v.* Paracentral	1923–31	Battle	179	1	0·56	3·0	369 to 1 against paracentral	Distinctly significant
		Paracentral	843	50*	5·93			
	1911–31	Battle	438	12	2·74	2·75	167 to 1 against paracentral	Significant
		Paracentral	911	57*	6·26			

* In two cases suppurative pylephlebitis was present on admission.

invisible bacteria. It is a matter of chance whether the bacteria or the antibodies are in the ascendant. If the former, the patient gets worse; if the latter, he improves. It is tempting to argue that the employment of drainage will do good in the former and will do no harm in the latter, so that the majority of surgeons use a drain in case of doubt. The risk of a drainage tube causing actual infection must be very small, judging by its use in other abdominal

cases such as in cholecystectomies. A joint factor that weighs is the difficulty sometimes experienced in diagnosing appendicitis in the early acute abdomen, especially in women, so that the paracentral incision is more often used. A distinct additional risk would appear to be taken in this way when acute appendicitis is actually found. This points to the need for a close study of the early case. On the other hand, when the signs indicate a median pelvic position for the appendix, the short, subumbilical, paracentral incision should prove safer than Battle's.

SUMMARY.

1. Statistical analysis of 1408 cases of acute appendicitis fails to justify any conclusion for or against drainage of the peritoneal cavity. This is a negative conclusion and indicates the difficulty of the subject.

2. With regard to the incisions employed, we find that much the lowest mortality occurs with the Battle incision. This should be the method of choice, except when there is doubt as to the nature of the case, notably in women, or when the appendix is median and pelvic in position.

Our thanks are due to Sir John Marnoch for the free use of his material over many years; to Dr. J. F. Tocher, Lecturer on Statistics in the University of Aberdeen, who has discussed the problems fully with us from the statistical point of view; and to many house-surgeons who have in turn helped in the laborious work of tabulating the 1923–29 cases fully and accurately.

THE SURGERY OF ENCAPSULATING CHRONIC PERITONITIS.

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Fagge and Hale-White described a peculiar form of chronic peritonitis which was associated with a chronic perihepatitis and a chronic perisplenitis. "The peritonitis", they found, "was always chronic and was never due to tubercle or a growth. The peritoneum was thickened and opaque; the omentum puckered up towards the colon, where it formed a transverse ridge; the mesentery was shortened, so that the intestines were dragged back towards the spine, and in extreme cases they became matted together into masses." These authors found that the main clinical manifestation of this chronic peritonitis was ascites, occurring as a complication of interstitial nephritis and also in syphilitic subjects.

After a perusal of the sparse literature on this subject, it would appear that it had a medical interest only as a rare cause of an ascites which occurs again and again after tapping. The object of this paper, however, is to show that this form of chronic peritonitis is also of surgical importance; that it may produce acute intestinal obstruction and an acute abdominal crisis; and that the operation necessary to relieve this condition must be based on an intimate knowledge of the pathology peculiar to it.

CASE REPORTS.

Case 1.—In 1921 I saw in consultation with Dr. Arthur Sherwin a man who was apparently suffering from an obstruction of the upper part of the small intestine. This patient had been seized with violent pains in the abdomen and had vomited continuously since the onset of the pains; efforts to get his bowels open had failed; his abdomen was slightly rigid but not distended, and had a firm, ovoid circumscribed swelling about as big as a child's head in the upper left quadrant. It was difficult to say what the cause of the obstruction was, but strangulation of a small intestine in an internal hernia was postulated.

The operation disclosed a peculiar pathological condition. When the parietal peritoneum was incised with the intention of opening the peritoneal cavity, it was found that the loops of small intestines were adherent to its deep surface and that the visceral and the parietal peritoneum were united to each other to such an extent that there was practically no peritoneal cavity. By careful dissection we obtained a limited space containing a straw-coloured fluid. With great difficulty we enlarged this space till it was possible to review the pathological condition. Neither the cæcum nor the sigmoid was visible, each being hidden from view by a glistening, opaque, milk-white membrane. The whole of the small intestine was coated with this membrane, and here and there intestinal loops had become so encapsuled with it as to form tumour-like masses, with the shape of the intestinal loops faintly showing through. This rigid false membrane was not distributed uniformly over the intestine: in some parts it was thin and moderately flexible. Intestinal loops were adherent to the parietal peritoneum; they were separated with great difficulty,

and when this was done it was seen that the liver and the stomach were similarly covered. The ovoid tumour which was felt on examining the patient was found to be one of these incarcerated groups of intestinal loops ; and an enormously dilated segment of the upper part of the jejunum, which was obviously obstructed, entered into this mass ; emerging from it was intestine of normal size.

Obviously we had here to deal with a case of intestinal obstruction caused by the adhesion of this encapsulating and contracting membrane, and the problem was how to relieve this obstruction. An attempt was made to liberate the intestine by incising the membrane and peeling it off ; but it was so firmly adherent to the underlying serosa that it was found to be impossible to do this. An attempt was then made to anastomose the dilated loop to a normal-sized one. With some difficulty, the bowel segments were mobilized and approximated, and the first layer of sutures of the anastomosis was inserted. Incisions were then made into the lumens of the bowel segments, when, to our surprise and discomfiture, the dilated bowel turned almost completely inside out through the opening, just like a complete extensive prolapse of the rectum. This, of course, was caused by the contractile character of the false capsule. It was found very difficult to right the prolapse, but finally by using interrupted sutures an anastomosis was constituted. As the sutures were under a certain amount of tension, a drain tube was led down to the vicinity of the anastomosis, and the abdominal wall was closed in the usual way. After the fifth or sixth day a fæcal fistula developed, and the abdominal wall soon became excoriated and painful from the acrid jejunal contents.

After many weeks of misery the fæcal fistula healed, and eventually the patient was discharged, relieved, at least apparently, of his obstruction. Nothing more was heard of this patient till many years later, when he presented himself with the history that he had for some time been suffering from 'gastric trouble'. He said that he vomited large quantities at the end of each day and that he suffered about four hours after meals from crampy pains, which were relieved if he vomited. An X-ray examination showed that he had an enormously dilated stomach which held many pints, and that very little food left the stomach in twenty-four hours. He was obviously suffering from pyloric stenosis in an extreme form. As his general condition was very bad on account of malnutrition, he was advised to submit to an operation for the relief of the stenosis ; but, probably with the unpleasant experiences of the last operation still present in his mind, he refused to do this. About three years later he was seen again : he had completely recovered and had been earning his living for some time. He said that he had undergone no treatment whatever ; at the present time he is alive and well.

There are many strange features in the history of this case : The investing membrane deposited over the whole of the peritoneum, obliterating the peritoneal cavity in parts ; the contractile nature of this membrane and its potentiality in causing multiple stenosis of the intestine ; and the natural cure of one phase of such a gross organic condition.

At the time the pathology and the treatment of this case presented a great puzzle to me ; but in the case about to be reported I was able to observe the development of this pathological condition from its very onset. My observations in this case, in conjunction with those just reported and with others recently published by French and German writers, have now made clearer to me the surgery of this unusual lesion, and will enable us to discuss it from a surgical point of view.

In March, 1927, I was asked to see a patient with the following history :—

Case 2.—A man, aged 47, had been suddenly seized with acute, crampy, abdominal pains, situated in the umbilical region. He vomited persistently and became constipated. Eventually his bowels were opened by means of enemas. His abdomen was slightly rigid in the upper part, but there was no distension. The condition was

regarded as a mild obstruction of the upper part of the small intestine, or perhaps a gall-bladder lesion. Subsequently these attacks recurred; and finally when I operated on him some months later the following condition was found:—

The omentum was quite devoid of any fat and had become thin and of white veil-like structure studded with tiny tubercles; the intestines were covered here and there with opaque, rigid, white plaques; the lacteals were very prominent as if they were dilated; the intestine was slightly contracted in the region of the plaques; the gall-bladder and stomach were spotted with patches of this membrane.

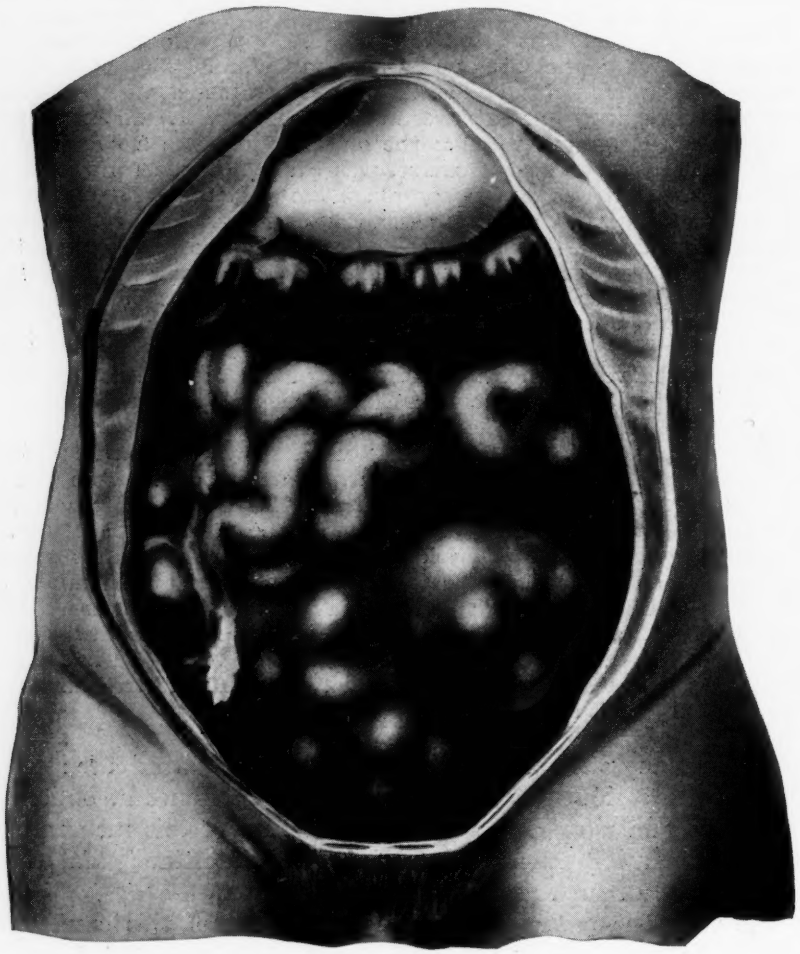

FIG. 76.—Tumour-like masses causing intestinal obstruction in a case of encapsulating chronic peritonitis. Stomach and small intestines are covered with a thick opaque contracting membrane. The colon is normal.

The rest of the organs were normal. There was no definite obstruction, and the attacks of pain were probably caused by painful intestinal peristalsis, resulting from the presence of the rigid plaques.

Pieces of the opaque membrane which were removed proved on microscopic examination to be a hyaloid membrane, having no definite structure and looking like degenerated fibrin. Section of the omentum showed degenerate structureless areas, corresponding to the tubercles. Taking the microscopic and macroscopic characters in conjunction, the condition looked like a patchy tubercular peritonitis in an early stage.

After this operation the patient was comparatively well for nine months, and then he began to get attacks of cramping abdominal pains, which were always associated with constipation. These gradually became more frequent and more severe, till one very bad attack which developed into an acute abdominal crisis. His pains became very severe ; he continuously vomited large quantities of brownish-yellow fluid ; and repeated enemas elicited neither flatus nor fæces. A tender, ovoid tumour the size of a child's head could be palpated in the left upper quadrant of the abdomen. It was obvious that the patient was suffering from an acute obstruction of the upper part of the small intestine, and that an operation was urgently necessary.

FIG. 77.—The intestines are shown after decapsulation ; the white opaque patches on the antiperistaltic section of the gut cannot be stripped off ; the dark parts are raw, bleeding serosa.

The pathological conditions found at the operations were as follows : The parietal peritoneum was about 2 mm. thick, and it was found difficult to open into the peritoneal cavity because of the subjacent adherent loops of small bowel and the extensive adhesion of these to one another. The extent of the peritoneal cavity was limited by these adhesions, and it contained a small quantity of straw-coloured fluid. The visceral peritoneum of the liver was uniformly adherent to the parietal peritoneum. The colon was normal. The abdominal glands were not affected.

The stomach and the small intestine were almost uniformly covered with an opaque, milk-white membrane 2 to 3 mm. thick, which here and there became thickened into cartilaginous plaques. The membrane had encapsulated groups of small intestinal loops into three smooth ovoid tumours, as illustrated in *Fig.* 76. The upper one, made up of jejunum, was the site of the obstruction, for the segment of jejunum entering it was hugely dilated. I was thus faced with the very great problem of determining how to deal with this high obstruction. My experience showed me that entero-anastomosis could not be done with safety. Even if this were practical, it was possible that obstruction was also present in the other incarcerated intestinal loops, because the jejunal obstruction would prevent it from becoming obvious ; furthermore, it was to be expected that the contractile membrane which had already formed the tumour was very likely to produce obstruction also. It was therefore obvious that the intestine had to be decapsulated—apparently a very formidable proceeding. After some prospecting it was found that the membrane was firmly adherent to the mesentery and to the antimesenteric border of the bowel, and comparatively loosely adherent where the peritoneum is reflected on to the bowel. At this spot I found a line of cleavage when the membrane was incised, which I followed, and by a process of peeling, dissecting, and unravelling the intestines were liberated. When this was done the whole of the intestine presented the appearance shown in *Fig.* 77. The raised white plaques are the places where the membrane could not be separated from the intestine. The dark parts are red, bleeding surfaces of intestine, which is altered serosa because this false membrane is superimposed on the serous membrane.

The wound in the abdominal wall was closed, and the patient made an uneventful recovery.

As the genesis of this peculiar pathological condition was uncertain, it was decided to exclude syphilis as a cause. Accordingly a Wassermann test by four different methods was made, and it proved negative.

Dr. Andrew Brenan, who made the microscopic examination of the membrane reported that the section showed " young fibroplastic cells with fairly plump nuclei."

About three months later the patient, who had been comparatively well, stated that a lump was developing in his abdomen and that he was again becoming constipated. Examination revealed that another of these encapsuled aggregations of intestines was forming. It was now decided to try the effect of deep X-ray therapy, and, with this point of view, Dr. Thwaites was consulted. The following were the specifications of the irradiation given to the patient :—

Volts	220,000
Milliamperes	4
Filters	0·5 mm. Zn plus 3 mm. Al plus 3 mm. asbestos
Focal distance	— 40 cm.
Port	Approximately 10 cm. × 8 cm.
Percentage of erythema dose	Approximately 75 per cent.

Special Details.—Tube output continuous and at constant potential. Rays employed homogeneous and of wave-length = 0·014 Å.U. (approximate).

Gradually, over a period of about three months, the tumour in the patient's abdomen disappeared and his bowels attained their normal function.

DISCUSSION.

Occurrence.—There is very little reference in English surgical literature to this rare form of chronic peritonitis. The form of chronic peritonitis described by Fagge and Hale-White alluded to in the beginning of this paper is probably a phase of this affection in which ascites is the predominant symptom. Under the name 'Zuckergussdarm' (icing-sugar intestine), German writers describe a perivisceral chronic hyperplastic peritonitis, which they term a perivisceritis,[1, 3, 5, 7] and which is obviously a similar condition.

Wilmoth and Patel have recently published a most illuminating article on this subject.[13] To the type of tumour formation which occurred from the envelopment of groups of intestines by this hyperplastic perivisceritis they give the name 'la péritonite chronique encapsulante'. *Fig.* 78, taken from this article, shows the abdomen of one of their patients opened with a median subumbilical incision. One of the tumefactions which this form of chronic peritonitis produces is visible. This tumour-like mass consisted of a large part of the small intestine, the uterus, and its adnexæ, enveloped by a tough, whitish, firmly-adherent membrane. A part of the small intestine and the colon was free. This patient suffered from peri-umbilical and lumbar pain over a period of about five or six years. At first the pains came on at long intervals, but latterly they had become more frequent and very painful. A gradually progressive constipation had developed into almost complete obstruction, which had necessitated an operation. The capsule was incised; a line of cleavage was discovered; and the membrane was laboriously removed little by little, until finally it was possible to release the intestine.

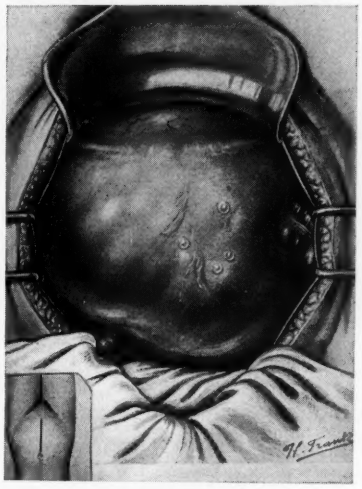

FIG. 78.—Isolated tumour enclosing uterus and part of small intestine. This simulated a pelvic tumour. (*From Wilmoth and Patel.*)

In this particular case, the membrane was examined by Professor Lecene, who reported as follows: "Fragments examined have a structure characteristic of a confluent tuberculosis, evolving in several parts as far as caseation; typical follicles, epithelial cells, giant cells of Langhans." *Fig.* 79 is a reproduction of the microscopic section.

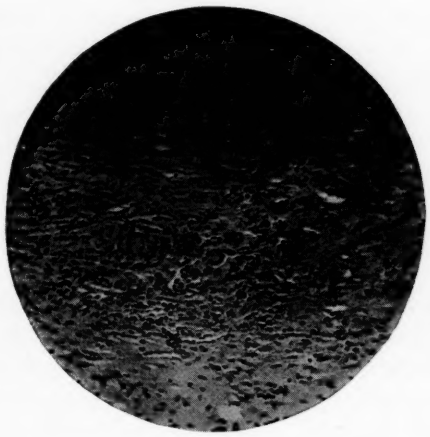

FIG. 79.—Microscopic structure of 'la péritonite chronique encapsulante'. (*From Wilmoth and Patel.*)

Esau,[3] who operated on a man 49 years of age with a diagnosis of multiple stenosis of the small intestine, discovered when he made the laparotomy three enormous white, vertical, sausage-shaped tumours coupled together, and containing nearly the whole of the small intestine. *Fig.* 80 shows the macroscopic appearance of this curious lesion.

We were fortunate that in *Case* 1 our observations extended over eleven years, and that in *Case* 2 we were able to study this disease from its very beginning over a period of years. We are able, therefore, to fill in certain gaps in the pathology of this subject which are missing in its literature.

Undoubtedly the chronic peritonitis described by Fagge and Hale-White

and the 'Zuckerguss' spleen of the German writers are etiologically the same as these chronic peritonitic affections here described by us, the clinical manifestations of which are mainly multiple intestinal stenoses. We have a parallel relation in the phases of tubercular peritonitis where its principal clinical manifestation may be in one instance ascites, and in another the formation of hyperplastic tubercular tissue with multiple stenoses of the intestine. It is also probable that the 'Zuckergussleber' (icing-sugar liver), and the 'Zuckergussmilz' (icing-sugar spleen) described by the German writers are also only phases of this disease. It is not possible to venture the opinion that the condition called 'polyserositis' in which all the serous membranes, including the pericardium and the pleura, are affected is of the same origin.

FIG. 80.—The appearance of the tumours in Esau's case.

Clinical Manifestations and Macroscopic Characters.—It should serve a useful purpose if, from our own observations and with the literature at our disposal, we summarize the main clinical manifestations and macroscopic characters of the various phases of this disease in so far as they are concerned with its surgery.

Early Stage.—In this stage the patient may suffer from attacks of colicky peri-umbilical abdominal pain. At first these attacks occur infrequently and at irregular intervals and are associated with constipation. They may simulate attacks of subacute appendicitis. The patient may suffer from a dyspepsia, not unlike the dyspepsia which occurs in certain early infiltrating forms of gastric carcinoma. The patient also suffers from mild, but definite, constitutional symptoms: loss of energy, loss of appetite, tendency to faint, attacks of sweating. The macroscopic characters at this stage were well exemplified by the conditions found at the first operation in *Case* 2. They may be described as follows:—

1. There is an irregular distribution of white, membranous, cartilaginous plaques over the small intestine.

2. In some parts of the intestine these plaques are very thick and are beginning to contract: they do not cause narrowing of the lumen of the bowel. They must, however, interfere with the peristaltic movement and cause it to become painful. They are the pathological basis for the attacks of colicky pain.

3. There is also a patchy, perivisceral distribution of this tough membrane over the stomach. This limits the distensibility of the stomach, probably causing a disorder of the normal painless peristalsis, as well as the dyspepsia.

4. The lesion is strikingly limited to stomach, small intestine, and liver.

At this stage, as indeed at any stage, it is quite impossible to make a diagnosis on the basis of the dyspepsia and the vague abdominal pains. The

question of the presence of an early gastric carcinoma will come into the consideration; while, on the other hand, the peri-umbilical colicky pain will suggest a diagnosis of appendicitis. A careful X-ray examination in our *Case* 2 gave us no information whatever; there was no delay in the small intestine.

Middle Stage.—Multiple intestinal stenoses; multiple tumour formation. In this phase of the disease all the clinical manifestations of an intestinal obstruction of the highest part of the jejunum occur. At this stage tumour formation also takes place. This is likely to be mistaken for a true tumour. The colon may be quite free from the membrane. The conditions disclosed at the second operation on *Case* 2 (*see Fig.* 76) exemplify this stage well. The macroscopic characters are as follows:—

A whitish, tough, opaque, membranous shell, varying from 2 mm. to 5 mm. thick, enveloping uniformly the whole of the small intestine and its mesentery. It is superimposed on the parietal peritoneum and is intimately and inseparably attached to it. This membrane is firmly attached to the deep part of the mesentery and to the intestines, but it is loosely attached where the peritoneum is reflected back from the mesentery on to the intestine. At this part it can be separated from the underlying serosa for a centimetre or two on to the intestine, and a line of cleavage obtained.

Late Stage.—Usually at this stage in addition to the tumour formations the peritoneal cavity is almost entirely obliterated. This is caused by the adhesions of the intestinal loops to one another and to the parietal peritoneum. The colon, as well as the other organs in the abdominal cavity, is now also covered with the membrane, which is now much thicker and more contractile, and so closely united to the serosa that it is separated only with the greatest difficulty. If an incision is made into the intestines at this stage, in the presence of this thick and very contractile membrane, the intestine will practically turn inside out. For this reason, therefore, it is dangerous to perform any anastomosis.

Stage of Isolated Tumours.—Not infrequently the uterus and part of the small intestines may be enclosed with this thick membrane in such a way as to form a tumour just like an ovarian cyst. Wilmoth and Patel[13] describe a case of this sort. *Fig.* 78, taken from their paper "La Péritonite chronique encapsulante", is an illustration of the condition. The tumour contains the uterus and part of the small intestine, and for a time was mistaken for a fibroma of the uterus.

It is particularly necessary to describe this isolated tumour manifestation, because a surgeon finding such a tumour at operation and not knowing the pathology of it would have great difficulty in dealing with it in the proper manner.

Etiology.—Different authors ascribe different causes for this condition. Fagge and Hale-White, finding it occurring with interstitial nephritis, regard it as a complication of this disease. Other authors regard syphilitic infection as responsible for the cause of this unusual form of chronic peritonitis. In this respect it is significant that the Wassermann test carried out by four different methods was negative in our *Case* 1.

Most French writers look upon it as an obscure, unusual manifestation of

a tubercular peritoneal infection. It would appear from their published observations that most of the evidence is in favour of this. Lehrnbecher found in one case an intraperitoneal caseous ganglion, and Outschinnihow has observed in such a membrane numerous disseminated tubercular granulations. In the section of the membrane in Wilmoth and Patel's case, illustrated in *Fig.* 79, the histological examination points to a confluent tuberculosis, evoluting at some points to caseation. The microscopic section of the membrane in its earliest stage in our *Case* 2, which showed no structure, indicates the early phase is a fibrinous exudation.

Strictly speaking, the terminology 'chronic peritonitis' is probably erroneous, for it is likely that this membrane is the result of a peritoneal inflammation which has been extinguished. In this respect it is significant that when the membrane has been extirpated, there is, according to Wilmoth and Patel, no recurrence. This does not tally with our observations. In *Case* 1 there was an exacerbation of the disease ten years later, when obstruction of the duodenum developed; certainly the membrane in this particular case was not extirpated. In *Case* 2, where the membrane had been partially ablated, a tumour re-formed three months later. This disappeared under deep X-ray therapy, and the patient has been well for the last four years.

Some inference may be drawn from the fact that a natural cure occurs. This was seen in *Case* 1. The patient had enormous gastric dilation, the result of gross duodenal obstruction, and refused operation. He got better without treatment and was well for many years.

Treatment.—Treatment will depend on the phase of the disease present. As this condition causes acute intestinal obstruction, urgent operation to relieve it may be necessary. The method of relieving this obstruction is the crucial surgical problem. A line of cleavage should be sought for where the peritoneum is reflected on the intestine. If this is found, it can be followed up and the intestine can be partially decapsulated and completely unravelled without much labour.

In late cases it may not be possible to find such a line of cleavage, as the membrane may be inseparably united to the intestines. If this is so, it may be necessary to try to perform an entero-anastomosis between the dilated and collapsed segments of intestines, or to perform total ablation of the obstructed loop. Both these procedures are fraught with the gravest danger, because the contractile membrane which is present in this late stage may cause complete inversion of the intestine, and because as a rule the stenoses or tumours are multiple.

If the patient is not in imminent danger of death from intestinal, duodenal, or pyloric obstruction, it is better to postpone operation. The treatment then should be deep X-ray therapy.

SUMMARY.

1. The occurrence of a peculiar and rare form of hyperplastic chronic peritonitis in two patients has been described.

2. The clinical manifestations and macroscopic characters of a very early stage have been described.

3. The progress of the disease has been traced, in two patients, over many years.

4. The surgical problem in relation to the release of the obstruction that this condition brings about has been discussed.

5. In order to make the clinical picture of this condition as far as possible complete, the observations made on these two patients have been added to those already published.

6. Its etiology has been discussed.

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THE REPAIR OF CLEFT PALATE.

By ALEX. MITCHELL, Aberdeen.

WITH NOTES ON THE ADMINISTRATION OF ANÆSTHETICS.

By J. ROSS MacKENZIE, Aberdeen.

Of all congenital defects, one of the most serious is a badly cleft palate, and the lot of the unfortunate victim of this deformity is in too many instances made harder when he is subjected to several unsuccessful operations. I cannot think of any operation which, when completed, seems so satisfactory but is so frequently doomed to complete failure. In many instances the failure is an operative one. The suture line which in a few days gives fair promise of success has by the end of a week broken down completely. In other cases in which operation has been done when the child has reached the age of three or four years and the suture has been satisfactory the functional result is poor, for although we have suceeded in uniting the cleft, the soft palate is immobile and drawn forward so that the space between its posterior margin and the pharyngeal wall can never be closed as is necessary for proper speech. What we must aim at is to ensure healing of the cleft with reasonable certainty and with safety in young children before they have begun to speak.

It is an axiom of surgery that the number of methods which have been suggested and practised for the cure of any particular condition is in inverse proportion to the success of any one of them.

For primary operations we have the old Langenbeck operation, the flap operation of Lane, and the Brophy method of forcible approximation of the cleft. In this country the Langenbeck operation as practised and popularized by Sir James Berry and others, has given good results in the hands of some, but it must be admitted that the general results are not good. The utilization by Veau[1] of the mucous membrane of the septum, Wardill's[2] plan of bringing forward the posterior wall of the pharynx to meet the shortened soft palate, and the Gillies-Fry[3] operation which aims at a perfect anatomical and functional result as regards the soft palate—leaving the cleft in the hard palate to the care of the dentist—are all methods which, although they have been successful in the skilled hands of their originators, are not likely to be, and in fact have not been, so successful in the hands of the general surgeon.

Operations which demand special skill in plastic work, considerable expenditure of time, and some risk to the lives of young and fragile children, can never prove a satisfactory solution to this problem.

My own experience extending over about twenty years has resulted in profound dissatisfaction. Unsuccessful attempts at the Lane operation led

to such extensive necrosis of tissue as to make any secondary operation impossible. The Langenbeck operation—the one usually employed—I have been able to perform in what seemed at the time a most satisfactory way—that is, the palate was sutured without injury to flaps and without undue tension; but in far too big a proportion of cases the suture line gave way badly. During the past year I have adopted a method which I had previously tried without success. It is a two-stage operation (*Figs.* 81–84).

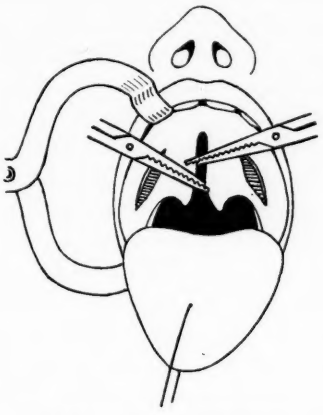

FIG. 81.—End of first stage.

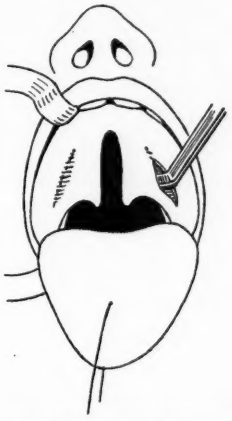

FIG. 82.—Beginning of second stage.

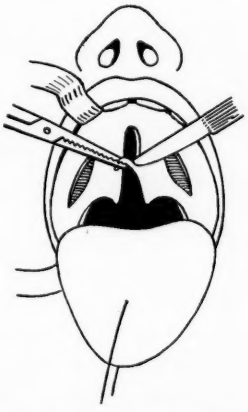

FIG. 83.—Second stage.

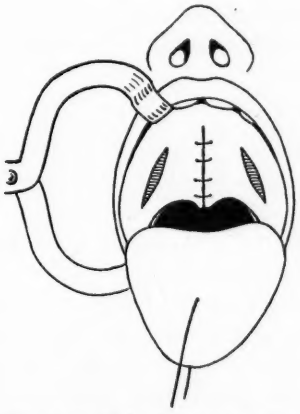

FIG. 84.—End of second stage.

FIGS. 81–84.—OPERATION FOR REPAIR OF CLEFT PALATE.

This method is not a new one and was recently mentioned in a discussion at the Royal Society of Medicine. The first stage is that of separation of the flaps, the second rawing of the edges and suture. Why this operation should not have been successful when tried out some years ago is now difficult to say, but possibly the second stage was done far too soon after the first. Since performing the operation in two stages with an interval of at least two weeks practically complete healing of the suture line has been obtained in all but one case. In order that this method may be carried out with success certain essential points must be observed:—

1. Neither operation should be unduly prolonged, for continuous and unnecessary handling devitalizes the tissues and prevents healing.

2. At no stage of either operation should excessive bleeding be permitted to occur.

3. The flaps should present a healthy and well-vitalized appearance, and there should be no appearance of sepsis in the mouth before the second stage is undertaken.

4. Rectal anæsthesia is the anæsthetic of choice for the second operation and no intratracheal or intranasal anæsthetic tubes should be employed.

First Stage.—For the first stage ordinary anæsthetic, preferably open ether with a preliminary dosage of atropine, is sufficient. The patient's head is dropped over the end of the table, the mouth held open by a simple gag, and the tongue drawn forward by a traction suture placed in the middle line. A small relaxation incision is made external to the posterior palatine artery on either side (*Fig.* 81). A gauze mop is placed on either incision and firm pressure made with the thumbs for two or three minutes to check bleeding. A little more anæsthetic may now be given if necessary. Then with fine elevators the separation of the palate is done, pressure with gauze being again applied. If any blood gets past into the pharynx it is at once removed by a suction tube. The last stage consists of cutting the attachment of the soft palate to the posterior margin of the bony palate. Pressure is re-applied until bleeding has stopped, and finally all the raw surfaces are painted with Whitehead's varnish. This concludes the first stage, which can be performed in about ten minutes.

Second Stage.—The second operation should not be undertaken until at least two weeks later. If there is still an appearance of sepsis in the mouth or if the child's general condition does not seem satisfactory, the operation may be safely postponed for another week. The longest period between the two operations in my cases was three weeks. For the second stage we prefer rectal anæsthesia, which may be supplemented if necessary by nitrous oxide gas and oxygen given through a small intra-oral tube. On examination of the mouth it will be seen that the only trace of the first operation is a narrow scar on either side representing the relaxation incisions (*Fig.* 82). Into each of these scars a palate elevator is gently inserted and it will be found that with very little effort and without fresh bleeding the flaps can be completely separated from the hard palate and brought to meet in the middle line. In some cases a little extension of the original incisions may be advisable. The opposing edges of the flaps are now rawed from end to end and sutures applied (*Figs.* 83, 84). Sutures of fine pliable silkworm gut are inserted by means of small cutting needles and Lane's needle holder. The use of the old-fashioned needles is to be deprecated as they are too broad and cause unnecessary injury to the tissues. The suture line is commenced in front and carried backwards, separate sutures being used in preference to a continuous one. After careful adjustment of the edges a few superficial sutures of six 0 catgut may be inserted. When the last stitch has been placed in the uvula it is drawn forwards so that the posterior surface of the soft palate is exposed and several fine catgut sutures are applied.

During this operation there is very little bleeding, and after it has been stopped by gentle pressure the suture line and the relaxation areas are painted over several times with Whitehead's varnish. Throughout both operations, and especially in the second stage, the greatest care and delicacy must be observed in handling the tissues.

After-treatment. — The following method of after-treatment has been found to be satisfactory :—

After the First Stage.—Rectal salines for three or four days every four hours. Sterile water by mouth for the first night. Sterile fluids, glucose and water, beef tea and chicken tea. No milk for three or four days, then light diet. Younger children have their mouths cleaned with saline solution and glycerin and borax applied later. Children who have been taught before operation to wash out their mouths use a mouth-wash of carbolic acid, liq. potassæ, glycerin, and water.

After the Second Stage.—Rectal salines every four hours for three or four days. Sterile water by mouth for the first day. For the next few days sterile glucose solution, beef tea, and chicken tea. Later on strained soup, fruit drinks, cocoa, and egg drinks until the stitches are removed, usually from the tenth to the fourteenth day. The care of the mouth is as in the first stage—the gums and teeth are swabbed after each feed, but the palate and suture line is not touched, the fluid being allowed to run into the mouth. When a sedative is required nepenthe in appropriate doses has been found most satisfactory.

Results of Operation.—The results of the cases treated by this method are infinitely superior to those I have been able to obtain by completing the operation in one stage, and I feel that what was unboubtedly the most unsatisfactory and disappointing section of my work can now be approached with confidence and with a reasonably sure hope of success. Whatever method of treatment be adopted, there are so many adverse factors at work that failures are bound to occur now and again ; but I am convinced that if the procedure which I have attempted to describe is followed, a surprising percentage of good results will be got. By good results I mean good operative results. The question of ultimate results as to function, i.e., speech, is more difficult, but I think the indication is fairly clear that if we are to have any hope of good functional results we must obtain a good operative result before the child attempts to speak, and that about one year or under is the best age at which to repair the cleft.

My intention is to apply the operative plan which I have outlined to children of about a year old, and by gradually reducing the age at which it is performed to gain more definite information. At present I do not see any reason why good results should not be obtained in children considerably under one year, and I feel that if they could be operated on at say six to nine months the functional results ultimately produced would be very much better than those we see at present.

During the past year I have operated on ten cases, the eldest aged 8½ years and the youngest 11 months. The average age was 2 years and 9 months. In one case in which the cleft was confined to the soft palate only

the suture line broke down completely. In all the others the suture was completely successful except in two cases where an additional stitch had to be subsequently inserted into the tip of the uvula.

I wish to express my thanks to Dr. F. J. T. Bowie for the accompanying sketches, and to Miss Adams, my ward sister, for the great care which she has always displayed in the after-treatment of these cases.

NOTES ON THE ANÆSTHETIC.

In few operations is the surgeon more dependent on the method and the character of the anæsthesia for a clear operation field than in cases of cleft palate. The induction of anæsthesia with ether or with ethyl chloride and ether presents no difficulty and usually suffices for the first stage of the operation, because when necessary the mask may be conveniently re-applied while hæmorrhage is being controlled by pressure in the relaxation incisions.

The problem that confronts the anæsthetist is the maintenance of the anæsthesia during the second stage of the operation. Frequently this is carried out by means of chloroform or a mixture of chloroform and ether, on a towel or in a Junker inhaler, or by endotracheal gas, oxygen, and ether through the nose. These methods are either unsatisfactory to the patient or inconvenient to the surgeon. Frequently at an important stage in the surgical procedure the anæsthetist urgently requires the operation field in order to maintain or to re-induce chloroform anæsthesia. Apart from the immediate risk on the table, chloroform devitalizes the tissues in the operation area and reduces the general recuperative powers of the patient. It is doubtful whether, with rare exceptions, the administration of chloroform to young children is ever justified. Nasal endotracheal catheters passing as they do in close proximity to the operation field, are a disturbing visual element to many surgeons.

In our experience the method of anæsthesia most suitable for the second stage of the operation is colonic oil—ether with paraldehyde. The procedure is as follows: A mild aperient on the morning prior to the day of operation is followed late in the afternoon by an enema and a 5-gr. chloretone suppository. The suppository is repeated on the morning of the operation. Atropine sulphate $\frac{1}{150}$ gr. hypodermically and nembutal $\frac{1}{3}$ gr. to 1 gr. by the mouth is given forty-five minutes before the time of operation. Nembutal appears to be a suitable sedative for infants, and children and induces sleep before and after operation. The mixture for injection consists of equal parts of olive oil and ether, and the dose is reckoned as 1 drachm for every 2 lb. of body weight. One drachm of paraldehyde is added to the dose.

The administration begins thirty minutes before the time of operation and is carried out, preferably with the patient on the operation table in the moderate Trendelenburg position. An elongated funnel is used and the catheter inserted through the anus to a distance just beyond the transverse rectal folds. The administration continues and is supervised by the anæsthetist until no oil-ether mixture returns to the funnel when it is lowered. This usually requires from twenty to thirty minutes.

For a clear operation field and an uninterrupted operation the pharyngeal reflex must be absent, and this necessitates a moderately deep surgical anæsthesia. Any delay in the development of the required depth of anæsthesia for beginning the operation can be corrected by the administration of a few drops of ether on a mask. The absorption of ether from the bowel will then be found to balance the elimination of ether through the pulmonary system and maintain anæsthesia. Any risk to the patient from overdosage or from abnormally rapid absorption of ether with respiratory depression and anoxæmia can be completely controlled by the administration of a mixture of oxygen with 5 or 7 per cent carbon dioxide through a flat, hook-shaped tube hung over the angle of the mouth. The tube should be fixed in position with a strip of adhesive plaster. Further, if it proves necessary, the colonic ether anæsthesia can be supplemented by means of gas, oxygen, and ether through this mouth tube without disturbing the surgeon. On return to the ward, two catheters are passed into the rectum, one of which is attached to a Higginson syringe or to a funnel, and the bowel is washed out with soap and water followed by saline until the odour of ether disappears from the returned fluid.

In conclusion two points require to be emphasized: (1) A history of recent enteritis contra-indicates this form of anæsthesia; (2) Our experience with colonic ether anæsthesia has been marked by the absence of any post-anæsthetic complications.

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MEGACOLON: EVIDENCE IN FAVOUR OF A NEUROGENIC ORIGIN.*

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Division of the sympathetic nerves of the colon is becoming increasingly popular as the surgical treatment of choice in cases of megacolon. The exponents of this form of treatment claim merely that the interruption of the sympathetic paths will remove all opposition from such detrusor ability as the dilated bowel enjoys: they do not postulate sympathetic overaction as the cause of the condition. Nevertheless, the remarkable efficacy of lumbar ganglionectomy,[1, 2] and of the simpler and more direct presacral neurectomy of Learmonth and Rankin,[3] demands that an effort be made to produce an experimental variety of megacolon by alteration in the extrinsic nerves of the bowel.

The alternative procedures that at once suggest themselves for this experimental purpose are prolonged stimulation of the sympathetic nerves of the colon, and the division of their parasympathetic antagonists. The latter method, obviously the more practicable, has been chosen here, and the effect on the colon of deprivation of its parasympathetic (sacral) nerves has been observed in a series of cats. The results of this experimental work are presented in this paper, and are correlated with the theories which have been previously formulated. To these is added an anatomical study of the nerves of the colon. The present interest in these colonic nerves renders unnecessary any apology for a repetition of anatomical detail. The pathology of megacolon as it occurs in man has been so closely observed and so fully described that it would be superfluous to discuss it here: attention will be drawn only to certain clinical and pathological phenomena which throw light on the origin of the condition. The figures given are based on 100 fully detailed cases taken at random from the extensive literature which envelopes megacolon, access to which can be gained by reference to the bibliographies compiled by Finney,[4] Barrington-Ward,[5] and Bartle[6] in their comprehensive essays in this subject.

ETIOLOGY OF MEGACOLON.

Megacolon can be defined as dilatation and hypertrophy of a part of the colon or of the whole colon, occurring in the absence of a gross obstructive lesion. It has been customary to divide cases of megacolon into the congenital and acquired varieties, the former presenting symptoms in infancy or

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childhood (in one case appearing so early as the seventh fœtal month), the latter not manifesting itself until adult life, and, most commonly, middle age. The 'acquired' cases may or may not be cases of congenital megacolon in which the condition is of slight enough degree to support life without symptoms during childhood and youth, but in which the dilated, hypertrophied, and overworked colon is the first tissue to succumb to the degeneration of advancing age. In megacolon the pelvic colon is affected alone in 37 per cent of cases, and in 34 per cent the upper part of the rectum or the whole of the rectum also suffers. The dilatation extends proximally to the ileo-cæcal valve in 25 per cent of cases, and in the remainder the descending, transverse, and ascending parts of the colon are involved with decreasing frequency. In 5 per cent of cases an associated dilatation of the bladder is described. Of 4 cases treated recently by Mr. N. M. Dott[7] in the Royal Hospital for Sick Children, Edinburgh, no fewer than 3 showed this complication, with in addition a high residual urine. Since in cases of megacolon the measurement of the residual urine is not a routine part of the investigation, the figure given above for bladder involvement probably underrates its true frequency. It is of interest that the bladder in these 3 cases shared with the colon the improvement which followed presacral sympathectomy.

Theories of Megacolon.—The theories advanced to explain megacolon fall into three groups: (1) Developmental; (2) Mechanical; and (3) Neurogenic.

1. *Developmental.*—It has been argued that the condition is a developmental dilatation with secondary hypertrophy (Mya[8]), developmental hypertrophy with secondary dilatation (Fenwick[9] and Genersich[10]), or combined dilatation and hypertrophy of developmental origin (Hirschsprung[11]), but the nature of the developmental error has not been explained.

2. *Mechanical.*—The valves (Wilkie[12]), torsion of a long mesocolon (Bartle[6]), kinking at the pelvirectal junction of a long pelvic colon (Marfan[13]), rectal and anal atresia (Treves[14]), and connective-tissue replacement of the muscle coat of the colon (Concetti[15]), which have been described as responsible for megacolon, are quite as likely to be sequelæ of that condition, and against all these suggestions is the small but definite percentage of cases which present a bladder also dilated. No mechanical change in the colon can be held responsible for a dilated bladder.

3. *Neurogenic.*—Megacolon has been ascribed to reflex spasm of the internal sphincter (Fenwick[9]), non-relaxation of the sphincter (Hurst[16]), paralysis of a bowel segment (Pennato[17]), and it will be observed that all these suggested causal conditions are compatible with a relative sympathetic overaction. Hawkins[18] considered the condition due to neuromuscular incoordination, i.e., non-relaxation or contraction of a ring segment at the moment when a peristaltic wave reaches it and demands dilatation. But this is advanced only as an attractive theory and has no evidential support. Monro Cameron[19] has described absence of the cells of Auerbach's plexus at the lower extremity in a case of megacolon, but other observers deny any reduction in the cells of Auerbach's plexus in these cases, and the reduction in the number of cells observed by Monro Cameron may easily be secondary to that chronic fibrosis which has been observed both in the bowel wall and in the mesocolon, the result of stasis in the bowel.

An argument in favour of a neurogenic origin for megacolon is of course the success of sympathectomy in the disease, although, as has been mentioned, the advocates of the operation rightly claim that the operation remains rational even though the nerves they divide are not responsible for the disease. An indisputable argument, however, in favour of a neurogenic origin for the disease is the occasional association with it of a dilated bladder. The only feature which bladder and lower colon share in common is their nerve-supply.

Two of Dott's[7] cases of sympathectomy for megacolon may be cited here. In the first of these the megacolon was associated with a mass of tuberculous glands overlying the presacral nerve, but not directly related to the enlarged bowel. This suggested that the colonic enlargement was due to stimulation of the sympathetic colon-dilator nerves at this point—an example in nature of that prolonged stimulation of a nerve which is so difficult to effect in the laboratory. In the second case the colonic and presacral nerves removed at operation appeared much thicker to the naked eye than those of children of the same age without megacolon. Sections of these nerves, however, when compared with apparently normal controls, showed not a numerical increase in fibres but an increase in epineural tissue. This can be explained as merely part of that connective-tissue excess throughout the mesocolon, the result probably of old-standing infection from the dilated bowel.

Clinically, therefore, it would appear that megacolon may be due to a relative sympathetic overaction. In cases of megacolon no anatomical alteration is found in the extrinsic nerves of the colon, and we have ourselves dissected the parasympathetic sacral nerves passing to the lower bowel of a 6-months-old child suffering from megacolon and found no abnormality in them. Histologically also in cases of megacolon little change can be observed in the cells and fibres of Auerbach's plexus, so that the lesion would appear to be functional rather than organic.

ANATOMY AND PHYSIOLOGY.

Anatomy.—For a proper understanding of the experimental work which follows, it is advisable to give consideration to the anatomy of those nerves that supply the pelvic viscera—the sympathetic and the parasympathetic. We shall deal only with the efferent fibres, first with those passing to blood-vessels in general, and secondly with those passing to the musculature of the viscera.

Sympathetic nerves leave the cord in common with the anterior roots of the spinal nerves from the 2nd thoracic to the 3rd lumbar inclusive. They arise from cells in the intermedio-lateral horn and their function is essentially motor. The sympathetic nerves leave the spinal nerves and pass to the appropriate ganglia of the sympathetic ganglionic chain as white rami communicantes. These fibres are medullated and constitute the pre-ganglionic fibres. Within the ganglion some of these fibres form a synapse around a nerve-cell and thence there arises a second set of fibres. These fibres are non-medullated and constitute the post-ganglionic fibres. These pass to the

appropriate spinal nerve as a gray ramus communicans and are distributed to the blood-vessels along with the branches of the spinal nerve.

Those sympathetic fibres that are destined for the various viscera take another course. They arise in the cord in the same way and pass to the lateral sympathetic ganglionic chain as white rami communicantes. They pass out from the ganglionic chain without a synapse and thus retain their essential character of pre-ganglionic fibres. Similar fibres from neighbouring ganglia tend to join up together and there is thus constituted a splanchnic nerve. The fibres in a splanchnic nerve end in a synapse in one of the peripheral ganglia, such as the cœliac ganglion, and thence the post-ganglionic fibres pass to supply the particular organ.

The sympathetic nerves for the rectum are collected in the hypogastric or presacral nerve of Latarjet,[20] which they reach through the middle and the two lateral (splanchnic) roots of that nerve (*Figs.* 85, 86). The middle root is the continuation downwards of the aortic or intermesenteric plexus, which has intimate connections above with the cœliac, the renal, and the superior mesenteric plexuses. In these plexuses the majority of the fibres of the middle root have their cell station. These fibres remain intact after the operation of lumbar ganglionectomy and their division is one of the advantages of the 'presacral operation' (Learmonth).

The lateral roots of the hypogastric nerve (the least splanchnic nerves) arise variably from the ganglia of the lumbar sympathetic chain, and pass forwards and medially to join with the lower extremity of the aortic plexus and form, at the level of the bifurcation of the aorta, the hypogastric nerve (*Figs.* 85, 86). The right lateral root has a connection of its own with the cœliac and both renal plexuses, while the left lateral root has a similar connection with the cœliac and the left renal plexuses (Learmonth[21]).

The hypogastric (presacral) nerve enters the pelvis and then splits into two main branches which pass round the side wall of the pelvis, each to end in the hypogastric ganglion of its own side, which lies on the lateral wall of the rectum. In these ganglia the remaining pre-ganglionic fibres of the hypogastric nerve have their cell station.

The sympathetic nerves for the pelvic colon leave the aortic plexus above the origin of the hypogastric nerve and pass outwards to be distributed with the branches of the inferior mesenteric artery. The lowest of these nerves (the superior hæmorrhoidal nerve) accompanies the artery of that name to end in the hypogastric ganglia.

The parasympathetic nerve-supply to the pelvic viscera arises as white rami communicantes from the 2nd, 3rd, and 4th sacral nerves. These nerves tend to join up to form one nerve-trunk which is known as the nervus erigens or pelvic nerve. This nerve passes through the hypogastric ganglion to have its branches distributed to the various pelvic viscera in common with the post-ganglionic sympathetic fibres. The parasympathetic fibres end in ganglia in the walls of the viscera they supply, and from these ganglia there pass very short post-ganglionic fibres to the muscles of the viscera.

On the hypogastric ganglion, therefore, converge the autonomic nerves for the pelvic viscera. The nerves diverging from the ganglion are mixed nerves composed of sympathetic and parasympathetic fibres.

Physiology.—Stimulation of the sympathetic nerves causes a contraction of the sphincters of the bladder and rectum and a dilatation of the walls of these viscera. Stimulation of the parasympathetic nerves causes an opposite effect—a dilatation of the sphincters and a contraction of the walls, to allow

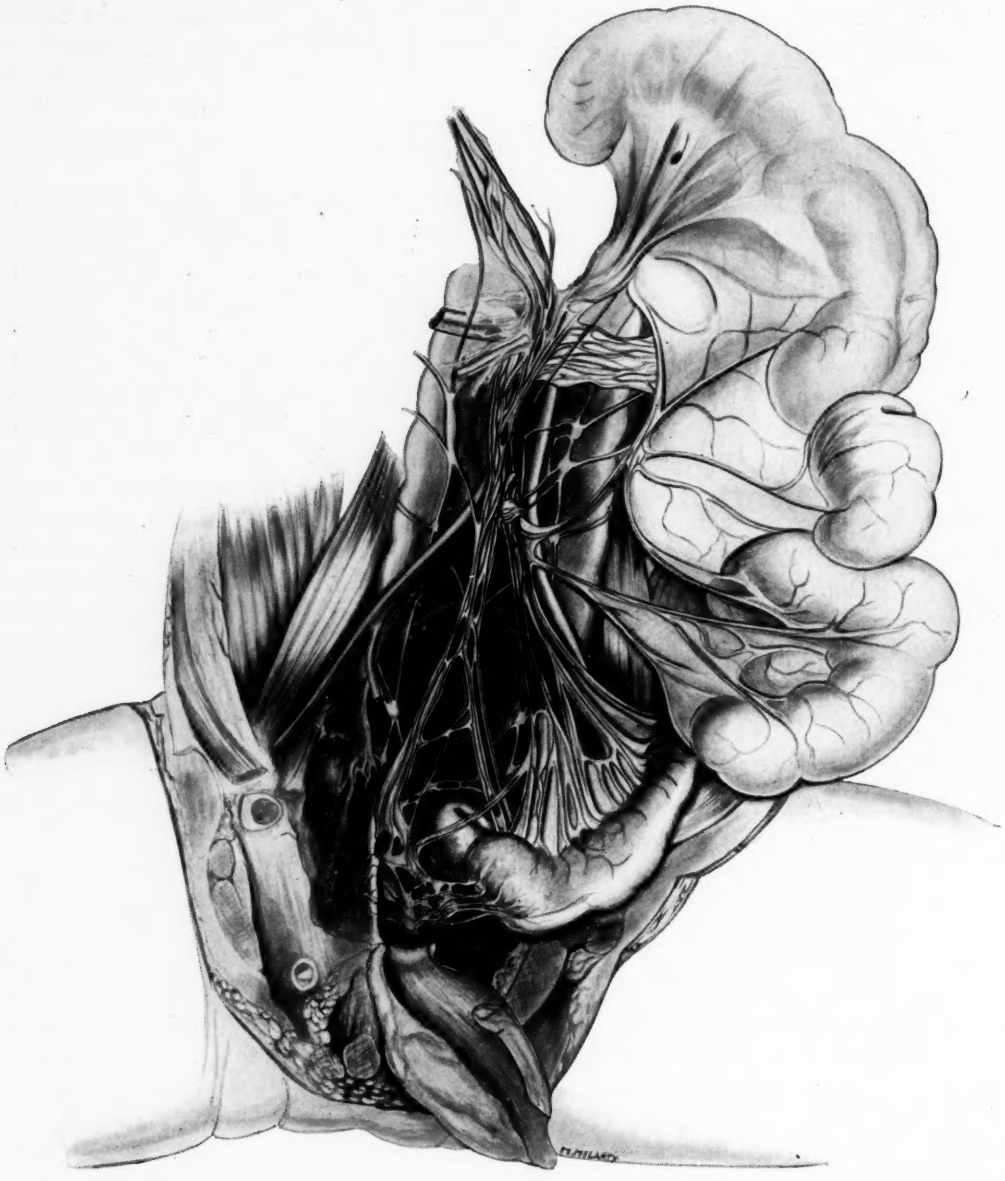


FIG. 85.—Dissection of a human female full-time fœtus to show the autonomic nerves of the lower abdomen.

of emptying of the particular viscus. In health we imagine the two sets of nerves to be in a state of physiological balance, the emptying of a viscus being determined by a relative overaction of the parasympathetic nerves,

and filling of the viscus by a relative overaction of the sympathetic nerves. Between the longitudinal and circular muscle coats of the colon, as of the whole intestinal tract, lies Auerbach's plexus of nerve-cells and filaments, without which it would appear that peristalsis cannot occur. The plexus has connections with the extrinsic sympathetic and parasympathetic nerves and its fibres end in the muscle cells of both coats of the bowel. A similar plexus (Meissner's) lies in the submucosa and is concerned with secretion.

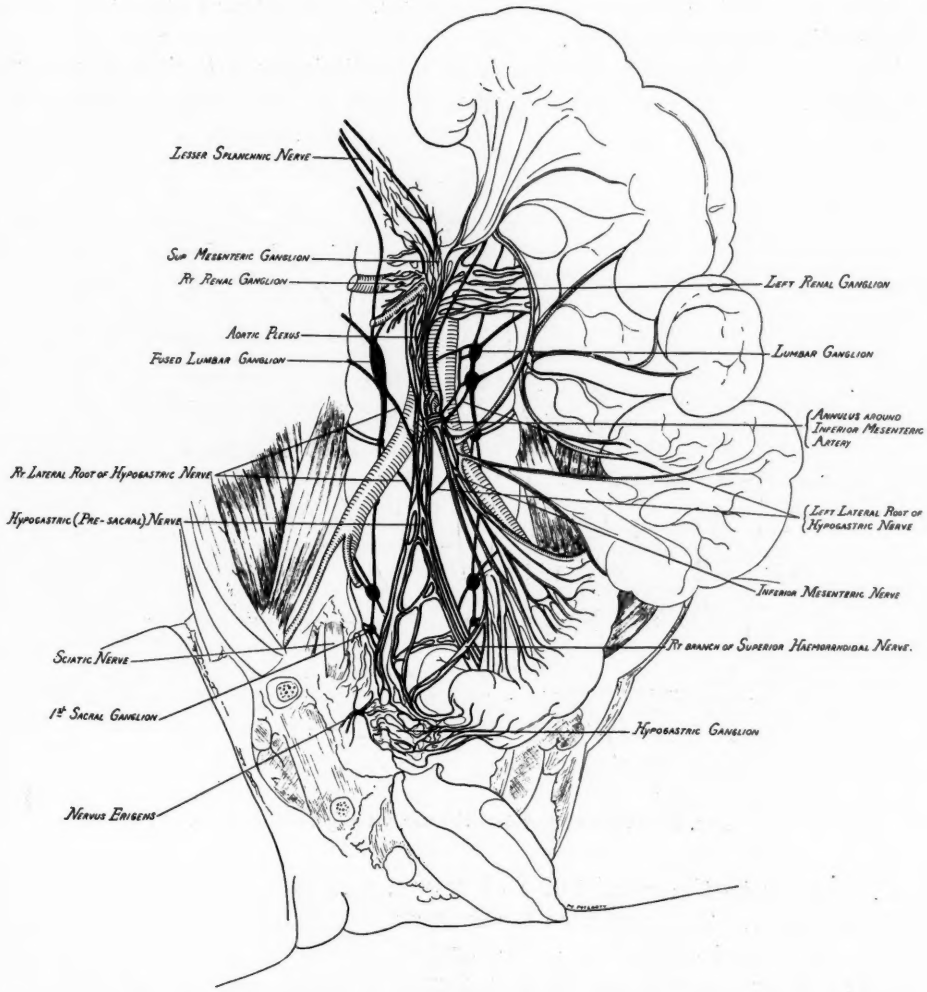


FIG. 86.—Autonomic nerves of the lower abdomen of a human female—a tracing of *Fig.* 85.

Anatomy of the Cat.—The anatomical arrangement of the autonomic nerves to the pelvic viscera in the cat differs only slightly from that found in man, in that there is a ganglion at the root of the inferior mesenteric artery (the inferior mesenteric ganglion) which serves as a cell station for the majority of the fibres of the hypogastric nerve. In this animal, therefore, the hypogastric ganglion is less cellular than in man.

EXPERIMENTAL MEGACOLON.

The aim of our work has been to produce experimentally a condition of megacolon of neurogenic origin. This could be achieved by upsetting the balance that exists between the parasympathetic and the sympathetic nerve-supply to the colon, so as to produce a relative overaction of the sympathetic nerves. This can be arrived at either by prolonged over-stimulation of the sympathetic nerves—a difficult thing to do experimentally—or by cutting out the action of the parasympathetic nerves. The latter course was chosen and the animals used were cats.

The cats were anæsthetized and, as a preliminary a barium enema was was given and a series of X-ray photographs taken. The barium, made

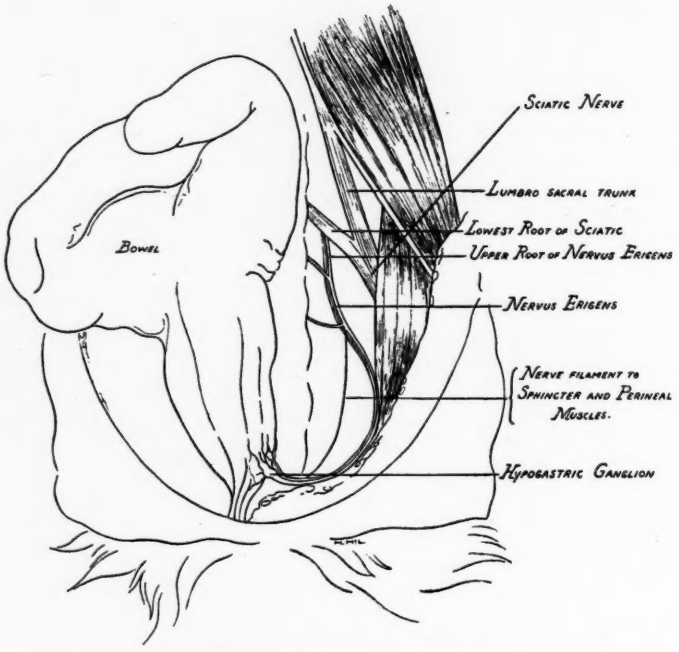


Fig. 87.—Arrangement of the nervus erigens in the cat.

up with water to the consistence of cream, was given through a No. 6 soft rubber catheter. To constitute a check on the quantity of barium injected it was decided to introduce the barium until a definite pressure was reached. After experiment it was found that a pressure of 55 mm. of mercury within the bowel was just sufficient to open the ileocæcal valve. With an enema given therefore at this pressure, we were confident of obtaining the X-ray photograph of a full colon. After the barium enema had been given, an X-ray photograph was taken and the animals were allowed to recover.

After a few days had been allowed for the animals to pass the barium, the operation for dividing the parasympathetic nerves was carried out. The abdomen was opened in the mid-line and the small intestine packed upwards.

The colon was pulled out of the abdomen and an incision made in the posterior peritoneum just below the bifurcation of the aorta, care being taken to avoid the presacral nerve. The edges of this incision were retracted and dissection carried down behind the rectum into the pelvis.

The landmark that was first displayed was the sciatic nerve. This was traced proximally, and passing from its lowest root downwards in a more vertical direction a small nerve—the uppermost root of the nervus erigens—was constantly found. The lower root or roots were then easily identified, and were traced proximally to their exit from the sacral foramina (*Fig.* 87). The arrangement of the roots of the nervus erigens, and indeed of the whole of the sacral plexus, varied considerably with the individual animal. In the majority the nerve had its origin by three roots, the uppermost of which was common to the lowest root of the sciatic nerve. In the operation the uppermost root was divided and the remaining roots were avulsed from the spinal canal, so as to minimize the possibility of regeneration. The trunk of the nervus erigens was itself divided proximal to the hypogastric ganglion, as large a segment as possible being thus resected. The procedure was carried out on both sides. The operation led to division of the parasympathetic nerve-supply to the colon and bladder.

The immediate effect of the operation was to cause the animals to suffer from retention of urine. Many methods were used in attempting to overcome the urinary difficulties. The employment of catheters, either permanent or intermittent, always led to infection of the bladder. Cystostomy, on similar lines to colostomy, with delay in opening the bladder till three days after operation, failed. Eventually it was found that opening of the bladder, stretching the bladder sphincter by the insertion of a pair of artery forceps through the bladder neck, and immediate closure of the bladder, achieved success and enabled the animals to live on indefinitely.

In addition to the division of the parasympathetic nerve-supply to the bladder and colon, the operation led to division of the voluntary nerve-supply to the external anal sphincter, the levator ani, and the perineal muscles, so that the sphincter became a flaccid ring and a mild degree of prolapse developed. The voluntary supply to these muscles usually ran in a small filament arising in common with the lowest root of the nervus erigens.

In all, 30 animals have been operated on. Of these, 25 have died at intervals after operation ranging from five to ten days. The cause of death in all these was renal failure. The post-mortem findings consistently showed a markedly dilated bladder, containing purulent urine which was often blood-stained. There was no dilatation of the ureters or of the renal pelves. The kidneys were congested and microscopic sections showed a marked degree of fatty degeneration with nephritic changes. These animals, therefore, died of renal failure from the backward pressure brought about by the loss of detrusor action of the bladder. The five animals that survived the operation continued to live in comparative comfort, and their bowels moved daily. At intervals after operation they were X-rayed after a barium enema, given at the standard pressure of 55 mm. of mercury. It was found constantly that after six weeks there was definite radiological evidence of dilatation of

the colon, and the quantity of barium held was increased. By the end of ten weeks the dilatation of the colon was well marked, and by the end of fifteen weeks, the longest period for which we were able to allow an animal

FIG. 88.—*Cat A.* Pre-operative appearance.

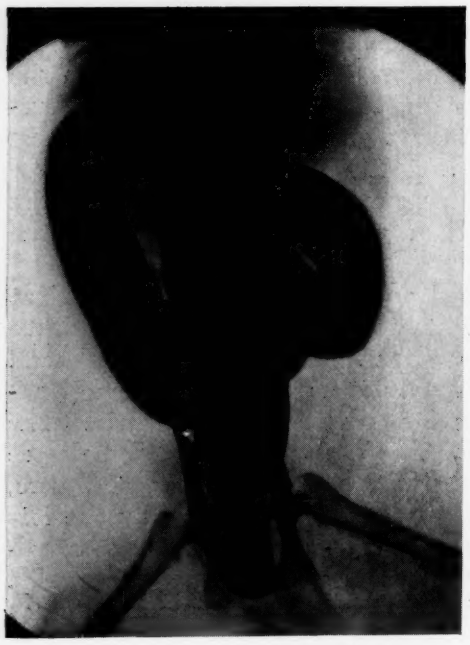


FIG. 89.—*Cat A.* Eight weeks after operation.

FIG. 90.—*Cat A.* Twelve weeks after operation.

to survive, the dilatation was gross. The dilatation of the bowel was thus progressive. At death a post-mortem examination was carried out and the illustrations show the condition of the colon. Microscopic sections were

FIG. 91.—*Cat B.* Pre-operative appearance.

FIG. 92.—*Cat B.* Six weeks after operation.

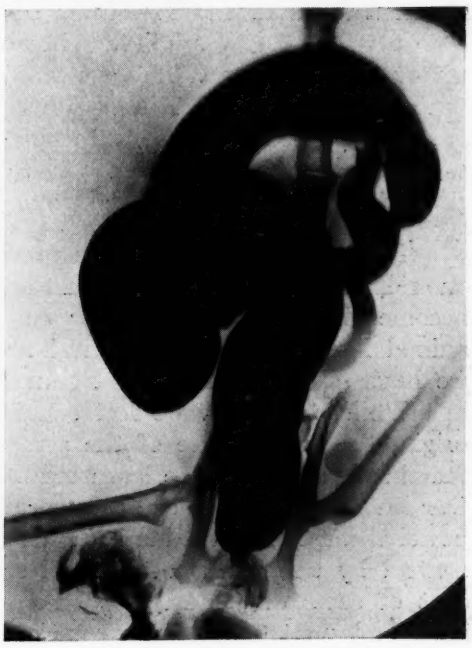
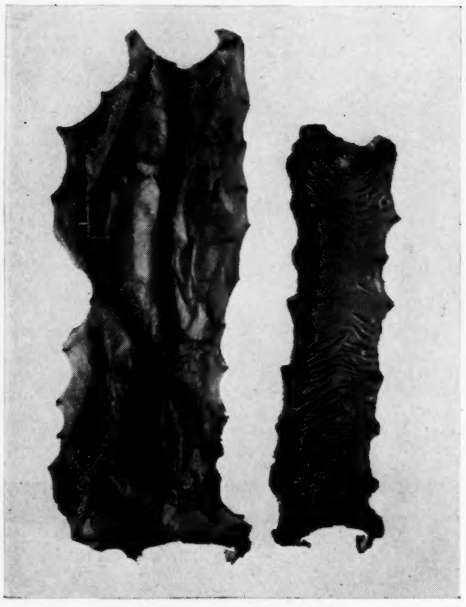


FIG. 93.—*Cat B.* Fifteen weeks after operation.

made of the wall of the bowel, and these showed virtually no hypertrophy of the muscle coats. Furthermore, we were unable to satisfy ourselves that there were any changes in Auerbach's plexus. The urinary bladders in these cases showed very marked hypertrophy, with some dilatation. There was also some infection of the bladder, while the kidneys showed congestion of the pelves and fatty degeneration of their parenchyma. We ascribed the cause of death to the changes in the kidneys. The X-rays and the illustrations of the specimens are of two cats, the first (*Cat A*) having lived for twelve weeks after operation, and the second (*Cat B*) for fifteen weeks after operation (*Figs.* 88–95).



A B

FIG. 94.—A, Colon of *Cat A*; B, Colon of normal cat of same weight and size.

A B

FIG. 95.—A, Colon of *Cat B*. B, Colon of normal cat of same weight and size.

Thus we have succeeded in producing experimentally a megacolon, based on relative sympathetic overaction. The condition took eight weeks to become obvious, and thereafter was gradually progressive for so long as the animal lived. This experimental result agrees with the conclusion to which we have already been led by clinical observation.

While, therefore, we feel convinced that the condition is of neurogenic origin, the exact cause of the sympathetic-parasympathetic imbalance must remain obscure until we learn more of sympathetic-parasympathetic balance. Our knowledge of the control exerted by the central nervous centres on the bowel through the medium of Auerbach's plexus, of the modification of that control by the glands of internal secretion (for megacolon occurs in 30 per cent of cases of acromegaly) and of the relation of the nervous system to growth, hypertrophy, and gigantism, is still too slender to serve as a basis for a complete theory of megacolon.

SYMPATHECTOMY FOR MEGACOLON.

The essential points in the operation of sympathectomy for megacolon as recommended by Learmonth are clear from the illustration (*Fig.* 96). It is necessary that all the sympathetic fibres to the rectum and pelvic colon be divided.

After the abdomen has been opened and the small intestine packed upwards and to the right, and the large intestine either drawn downwards or out of the abdomen, the peritoneum over the bifurcation of the aorta is incised in a vertical direction for about 3 in. By a process of blunt dissection

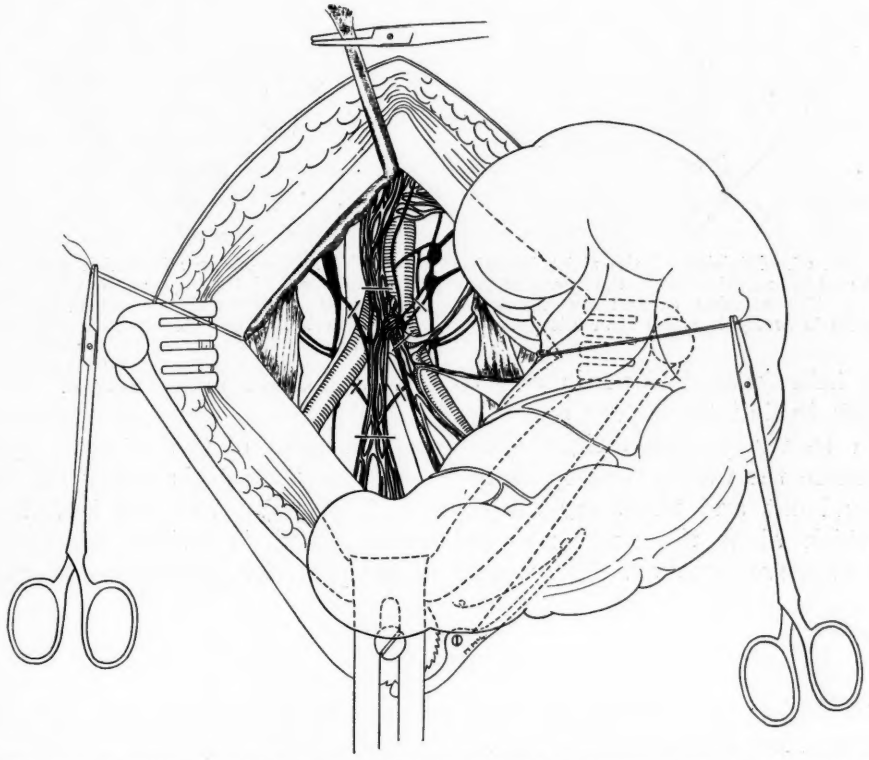


FIG. 96.—Situations at which the sympathetic nerves of the lower colon are to be divided in the operation for megacolon.

the bundle of nerve-fibres constituting the hypogastric or presacral nerve is easily found lying in the retroperitoneal tissues. The hypogastric nerve is followed downwards for about 1 in. and is then divided across between artery forceps. The forceps on the upper cut end of the nerve then acts as an efficient retractor. By drawing the nerve over to the patient's left side, the root from the 4th right lumbar ganglion becomes evident passing either in front or behind the common iliac vessels. This is divided, and the roots from the 3rd, 2nd, and 1st lumbar ganglia are divided as they come into view. These may be separate connections or in the form of a single lateral root. By further drawing on the nerve in a downward direction the middle root

from the aortic plexus is made to stand out and is divided. The left root of the nerve is then displayed and the connection from the 4th left lumbar ganglion divided. The left root is traced upwards and is found either to pass in front of, or behind, or as an annulus around the root of the inferior mesenteric artery. The commonest arrangement is the last. The anterior loop around the artery is divided (*Fig.* 97) and this permits of the whole

FIG. 97.—Division of the right lateral root and the middle root of the hypogastric nerve. The annulus around the inferior mesenteric artery has also been slit up.

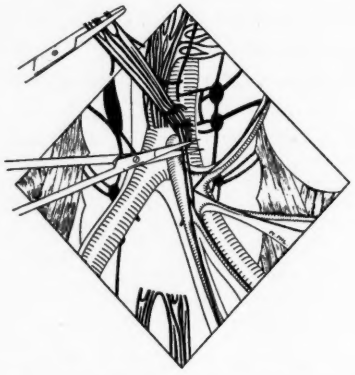


FIG. 98.—Manner in which the whole of that part of the hypogastric nerve to be removed is swung up behind the inferior mesenteric artery. The inferior mesenteric nerves are about to be divided, and the left lateral root of the hypogastric nerve will be divided at the points marked.

nerve being passed upwards and to the left behind the artery and then drawn to the patient's right above and in front of the artery. By this manœuvre the nerves passing along the inferior mesenteric artery are made to stand out and these are all divided (*Fig.* 98). The left lateral root, by which alone the nerve now remains attached, is divided and the segment of nerve removed. The wound in the posterior peritoneum is sutured and the abdomen closed.

SUMMARY.

1. Clinical evidence is brought forward in support of the view that megacolon has a neurogenic origin.

2. Experimentally it is shown that a gradually progressive megacolon can be produced in the cat by removal of the parasympathetic nerve-supply to the distal colon.

3. A description of the autonomic nerves to the distal colon in the human subject is given, with the operative procedure recommended in cases of megacolon.

This work has been carried out with the aid of a grant from the Earl of Moray Endowment Fund. We would express our gratitude to Professor Wilkie, who has afforded us facilities in his department which have made this work possible and whose encouragement and criticism have been particularly valuable. We are indebted to Mr. J. M. Graham for advice in planning our study, and to Mr. N. M. Dott for his kind permission to mention his cases

of megacolon. We have had valued help from Sir Arthur Keith in drawing our conclusions, and from Dr. F. E. Reynolds in the field of neuro-histology, and to these we would tender our thanks. It only remains to mention Mr. Frank Pettigrew and the staff of the Surgery Research Department of the University of Edinburgh for their skilled assistance. The drawings are the work of Miss McLarty.

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THE END-RESULTS OF PERINEAL EXCISION AND OF RADIUM IN THE TREATMENT OF CANCER OF THE RECTUM.

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In the following study a survey is made of 370 cases of rectal cancer in which perineal excision was performed in St. Mark's Hospital from 1910–31, and of 89 cases in which radium has been employed since the latter part of 1928.

PERINEAL EXCISION.

The Operation.—The operation has been that described by Lockhart-Mummery[1] in 1920. At a preliminary operation a left rectus or left iliac colostomy is established. The colostomy has in many cases been a 'blind' one, without any attempt at abdominal exploration; in other cases the abdomen has been explored through the rectus incision through which the colon was finally brought out, or it has been explored locally through a left oblique muscle-split. In a considerable number of cases the abdomen has been thoroughly examined through a paramedian incision, the colostomy being brought out through a separate left oblique incision, and, personally, I favour the last mentioned routine.

The perineal excision has in most cases been performed seven to fourteen days after the colostomy operation. In the last ten years the operation has been done in the majority of cases under spinal anæsthesia, either combined with gas and oxygen, or in conjunction with preliminary narcosis by morphia and scopolamine, avertin per colostomy, or nembutal by mouth. The excision operation has been done with removal of the sphincters, the coccyx, and sometimes a portion of the sacrum. The peritoneum has been opened, the bowel freed and divided well above the growth, with as high ligation of the vascular pedicle as each case permitted. The bowel has been closed by suture and the peritoneal floor repaired.

Operability Rate of Cancer of Rectum.—Before describing the immediate and remote results of perineal excision, the following tables are recorded showing the operability rate in St. Mark's Hospital. The twenty-two years 1910–31 inclusive are divided into two periods of eleven years each, and the way in which the rate has been estimated is clearly shown by recording the different types of treatment that have been given; a summary of the hospital practice in relation to rectal cancer is thus obtained (*Tables I, II*). It will be noted that the operability rate has risen from 41·6 per cent in the first period to 54 per cent in the last eleven years.

The Cancer Follow-up Scheme at St. Mark's Hospital has rendered possible the compilation of these tables, as every case of cancer admitted

into the hospital has been included in the scheme and has been cross-referenced according to the treatment given. The tables are self-explanatory and only certain items need elaboration.

Table I.—Operability Rate, 1910–20.

Operable *		Inoperable	
Perineal excision	78	Palliative colostomy	187
Abdomino-perineal excision	37	Exploratory laparotomy	6
Abdomino-anal excision	8	Expectant	24
Perineal excision with preservation of anus	4		
Perineal excision with sacral anus	11		
Hartmann's operation	1		
Local resection	5		
Expectant (refused operation)	11		
Total	155	Total	217

* In 372 cases 155 were operable = 41·6 per cent.

Table II.—Operability Rate, 1921–31.

Operable *		Inoperable	
Perineal excision	292	Palliative colostomy, alone or in conjunction with radium	281
Abdomino-perineal excision	39	Exploratory laparotomy	3
Perineo-abdominal excision	10	Radium without colostomy	14
Hartmann's operation	3	Expectant	24
Local resection	7		
Radium	16		
Expectant (refused operation)	9		
Total	376	Total	322

* In 698 cases 376 were operable = 54 per cent.

1. The cases classified as local resections were either early operable cancers which were removed *per vias naturales* or by posterior proctotomy, or they were villous tumours or adenomata which were removed by the same routes and were proved on section to have undergone malignant degeneration.

2. Squamous carcinoma of the anal canal and anus is included in estimating the operability rate, and accounts for 8 of the operable cases shown in *Table II* as having been treated with radium.

3. No case is included twice in these tables—for instance, cases of colostomy followed by perineal excision are shown under perineal excision only; cases treated by radium followed later by perineal excision are similarly grouped under perineal excision only.

4. The radium cases have been assessed as operable or inoperable as accurately as possible, and grouped accordingly.

5. Inoperable cases grouped under palliative colostomy represent a small

error, for contained in this group there are some cases of inoperable carcinoma of the colon. It has not been possible to go through the entire series of case cards to separate the colon cases, and on this account the operability rate, so far as the rectum is concerned, should really be slightly higher than the figures as now quoted.

Operation Mortality of Perineal Excision.—The following collected figures from St. Mark's Hospital summarize the results of a group of operators and provide an accurate record of the progress that has been made with this operation in the course of the last twenty-one years. The operation mortality will be set out in three ways: (1) In relation to increasing experience with the operation; (2) In relation to age and sex; (3) In relation to the stage of the disease. In these tables operation mortality includes every case that died within four weeks after operation.

Increasing Experience with the Operation.—Examination of *Table III* shows that there has been a progressive decrease in the operative death-rate from 16 per cent in the first 100 cases to 10 per cent in the third 100 cases, and there is a good prospect that when the fourth 100 cases have been completed the mortality will prove to be down to a single figure. The mean operative mortality at present works out to 11·6 per cent (43 out of 370 cases). These results are a testimony to the keenness, co-operation, and

Table III.—Operative Mortality of Perineal Excision in Relation to Increasing Experience with the Operation.

		M.	F.	Date	Operative Mortality	M.	F.
First	100 cases ..	68	32	1910–22	16	11	5
Second	100 ,, ..	66	34	1922–27	13	11	2
Third	100 ,, ..	68	32	1927–29	10	8	2
Next	70 ,, ..	47	23	1930–31	4	3	1
Total	370 ,, ..	249	121	1910–31	43	33	10

good team work of everyone who is concerned with the cases. Zealous preparation and after-care, together with the extensive use of spinal anæsthesia, have been important factors. The decrease in the death-rate among males in recent years is noteworthy, and is, in my opinion, largely due to the interest which Dr. Dukes has stimulated in the subject of urinary infections and their prevention. His intensive campaign on this question and the evolving of his retained catheter apparatus dates from 1927–8. Its influence is clearly shown in this table in the decrease in actual male mortality from 16·2 per cent in the first 100 to 11·7 per cent in the third 100 cases. The table also shows the greatly increased number of these operations that are being done at the hospital; whereas it took twelve years to complete the first 100 cases, the fourth 100 will probably be completed in three years or less.

Age and Sex.—It will be seen from a study of *Table IV* that male cases represent slightly more than two-thirds of the total, with a mortality of 13·25 per cent (33 out of 249), the female mortality being 8·3 per cent (10 out of 121).

Table IV.—Operative Mortality in Relation to Age and Sex, in 370 Cases of Perineal Excision (1910–31 inclusive).

Age Incidence in Years	Total Number Operated upon		Number of Operative Deaths	
	Males	Females	Males	Females
20–29	4	2	1	—
30–39	10	11	1	—
40–49	49	21	3	2
50–59	94	42	12	2
60–69	80	38	11	5
70–79	12	7	5	1
Total	249	121	33	10

As regards age, 137 out of the total of 370 were subjects over 60 years of age, and the fact that in this series 19 patients over 70 years old have been operated upon shows that advanced age has not in itself been considered a bar to perineal excision. The heavier mortality in males over 70 years of age (5 deaths out of 12) is to be expected and was actually caused in this series by the following conditions: sepsis, cardiac failure, uræmia, exhaustion, and bronchopneumonia.

Operative Mortality in Relation to the Stage of the Disease.—The method of pathological classification of rectal cancers according to depth of spread has been described by Dukes.[2, 3] Briefly, his method is to incise the specimen, generally along the middle-line anteriorly; the specimen is then pinned out to keep it flat and stretched. Fixation is effected in formol-saline and the measurements are taken of the length of the specimen, the size, situation, and extent of the tumour, together with the amount of free margin of bowel above and below. The growth is then sectioned through what appears to be the point of maximum penetration of the bowel wall by the growth, or at the point of deepest ulceration. Any enlarged lymph-nodes in the mesorectum are identified by a series of thin transverse slices. Suitable blocks of the growth and lymphatic territory are prepared and sectioned: examination of the sections under a low power of the microscope enables the cases to be grouped in the following way:—

"*A cases* are those in which the carcinoma is limited to the wall of the rectum, there being no extension into the extrarectal tissues and no metastases in the lymph-nodes.

"*B cases* are those in which the carcinoma has spread by direct

continuity to the extrarectal tissues, but has not yet invaded the regional lymph-nodes.

" *C cases* are those in which metastases are present in the regional lymph-nodes." (Dukes.)

Table V shows that in *A* cases (32) the operative mortality was nil, in *B* cases (53) it was only 3·8 per cent, whereas in *C* cases (71) it was 12·7 per cent. This very instructive finding shows that a group of surgeons has been able to carry out 85 perineal excisions (groups *A* and *B* combined) with only 2 deaths (2·4 per cent), and suggests that once the necessary skill and experience have been obtained the mortality depends almost entirely upon the number of advanced *C* cases that are tackled by radical operation.

Table V.—Operative Mortality in Relation to Stage of Disease. Classification by Dukes' Method according to Depth of Spread (1927–31).

Classification of Growth	Number Submitted to Operation	Died from Operation	Operation Mortality
			Per cent
A	32	0	0·0
B	53	2	3·8
C	71	9	12·7
Total	156	11	7·0

At St. Mark's Hospital the principle upon which excisions have been done has been that it is worth while to excise any rectal cancer that is not hopelessly fixed, provided that metastases to the liver have not occurred. A deeply ulcerated growth with metastases in the glands may be just capable

Table VI.—Immediate Causes of Operative Deaths.

Immediate Cause of Death	Number	Males	Females
Heart failure, shock, hæmorrhage and exhaustion	16	12	4
Sepsis	14	11	3
Urinary complications	5	4	1
Pulmonary complications	3	3	0
Intestinal obstruction	3	2	1
Pulmonary embolism	2	1	1
Total	43	33	10

of removal before it has irremediably penetrated into the prostate or bladder base; if the operation mortality is under 15 per cent, such an operation would appear to be worth while, and even if recurrence in the abdominal glands or liver should present itself within three years, the local removal of the growth will be justified by the freedom from pain and from local complications, such as rectovesical or rectovaginal fistulæ, which might otherwise have developed.

The Immediate Causes of Operative Deaths.—Table VI shows the causes of the 43 operative deaths in this series.

It will be observed that, contrary to the usual findings, 'sepsis' takes second place in the list of fatal complications. An unfortunate series of 4 fatal secondary hæmorrhages and 1 fatal reactionary hæmorrhage, probably due to an alteration in the technique of ligation of the superior hæmorrhoidal pedicle, puts the vascular complications at the head of the list. The small number of fatal chest complications, amounting to less than 1 per cent of the operations performed, is noteworthy. The 3 cases of intestinal obstruction were due to small-gut obstruction round the colostomy (2) and obstruction through the pelvic floor (1).

Late Results of Perineal Excision.—The late results of perineal excision are shown in *Tables VII* and *VIII*, drawn up on the generally accepted lines to show ten-year and five-year cures, and also in *Table IX*, which shows three-year cures grouped according to the proved depth of spread (groups *A*, *B*, and *C*).

Table VII.—Results of Perineal Excision at 10 Years.

Total number of cases operated upon, 1910–21 inclusive		91
Operative deaths		14
Survivals from operation		77
Alive and well at present time (1932)	17	20
Survived ten years and died from other causes	3	
Died from recurrence	36	47
Died from cause unknown	11	
Died from other causes in less than ten years	8	10
Untraced	2	

If we subtract the 10 cases who are untraced or died from other causes in less than the ten years from the 77 survivals from operation, we obtain the figure of 67 cases, of whom 20 have been cured on a ten-year basis, i.e., 30 per cent.

Table VII may be elaborated by supplying the following facts: The longest-living survivor is a man upon whom Mr. Swinford Edwards operated in December, 1911—over twenty years ago. Colostomy and perineal excision were performed, the patient's age being 33. He has recently been re-examined; he is in good health and has a good colostomy, the perineal wound is soundly healed, and there is no sign of recurrence. The period of survival of the other 16 cases is 17 years, 15 years (4 cases), 14 years (3 cases), 13 years (4 cases), 12 years, and 11 years (3 cases). Three patients died from other causes 15, 12, and 12 years after operation. No patient died of recurrence who survived the ten-year period. The small number of untraced cases (2) is noteworthy: one of these patients went to Australia three years after

operation and has not been heard of since, and the other, operated upon in 1920, has never been traced.

Table VIII.—Results of Perineal Excision at 5 Years.

Total number of cases operated upon, 1910–26	..	189
Operative deaths	..	26
Survivals from operation	..	163
Alive and well at present time (1932)	45	55
Survived five years and died from other causes ..	10	
Survived five years and died from cancer	6	8
Alive after five years with recurrence	2	
Died from recurrence in less than five years	68	88
Died from cause unknown	20	
Died from other causes in less than five years	10	12
Untraced	2	

Table VIII is self-explanatory: if the 'untraced' and 'died from other causes' are subtracted from the operation survivals, 36·4 per cent of five-year cures are revealed (55 out of 151). Special mention should be made of the 6 cases that survived the five-year period and later died from cancer. Their deaths occurred as follows:—

5 years and 2 months ..	Growth in right lung, probably independent.
5 ,, ,, 7 ,, ..	Recurrence in blind segment of colon below colostomy.
5 ,, ,, 9 ,, ..	Recurrence in vagina and pelvis.
6 ,, ,, 7 ,, ..	Recurrence in blind segment of colon below colostomy.
7 ,, ,, 5 ,, ..	Recurrence in blind segment of colon below colostomy.
9 ,, ,, 2 ,, ..	Growth in right lung and in glands of neck.

The 3 cases in which recurrence took place in the bowel below the colostomy are noteworthy; these were probably carcinomas arising independently in pre-existing adenomata, and indicate the importance of removing as great a length of bowel at operation as possible. If these 3 cases, together with the 2 cases dying after five years of cancer of the lung without evidence of local or abdominal recurrence, are reckoned also as five-year cures, the figure for five-year cures becomes *40 per cent* (60 out of 151).

Table IX.—Results of Perineal Excision at Three Years Classified according to Proved Depth of Spread of the Growth.

Classification of Growth	Number of Cases (1927–March 1929)	Died from Operation	Died under 3 Years		Untraced	Alive at 3 Years	Percentage of 3-year Cures
			Of other Causes	Of Cancer			
A	15	0	1	2	—	12	86
B	24	1	—	6	1	16	73
C	21	4	1	13	—	3	19
Total	60	5	2	21	1	31	60

In *Table IX* the percentage of three-year cures after perineal excision is shown, with the cases classified according to the proved depth of spread. The percentage of cures is worked out from the usual fraction—

$$\frac{\text{alive at three years} \times 100}{\text{number of operation survivals less those untraced and died from other causes}}$$

It will be seen that in *A* cases there is the remarkable figure of 86 per cent of three-year cures, in *B* cases the percentage is 73, whereas in *C* cases it drops to 19. The difference in the prognosis of the three groups is thus strikingly indicated, and is likely to be more marked when time has elapsed for a similar table on a five-year basis to be drawn up.

RADIUM TREATMENT.

The treatment of rectal cancer by radium needle barrage has been carried out in St. Mark's Hospital since the latter part of 1928. The methods employed have been those described by Neuman and Coryn,[4] and by Sir Charles Gordon-Watson.[5, 6, 7] Minute details of technique need not be described here, and it will suffice to state that :—

1. An ample supply of radium has been available in amounts of 0·5, 1, 2, and 3 mgrm. per needle.
2. The needles have varied in length from 1·9 cm. to 6 cm.
3. The filtration has been 0·5, 0·6, and 0·8 mm. of platinum.
4. In placing the radium needles every effort has been made to obtain an even and well-distributed barrage.
5. In estimating dosage the principle has been to give as heavy a dose as seemed reasonable for each particular case. The average duration of the radium exposure has been six to eight days.
6. Radon seeds have been used in a few of the more recent cases.

The following report covers the complete series of 89 cases of rectal cancer that have been treated with radium in St. Mark's Hospital from 1928–31 inclusive. In some of the cases the radium treatment has been carried out from more than one aspect—for instance, an original abdominal or vaginal barrage has sometimes been followed by intrarectal insertion of radium needles or radon seeds, but the principal attack has been the first one and the cases have been classified for the sake of clearness in the following way :—

		Cases
I.	*Carcinoma and Sarcoma of the Rectum*—	
	1. Operable cases treated with radium	14
	2. Radium in conjunction with perineal excision	11
	3. Abdominal radiation	16
	4. Posterior barrage	9
	5. Interstitial needling for inoperable cancers	18
	6. Recurrent carcinoma	9
II.	*Squamous Carcinoma of the Anus and Anal Canal*	12
	Total	89

I. CARCINOMA OF THE RECTUM.

1. Operable Carcinomas Treated with Radium.—Fourteen operable carcinomas have been treated with radium: there were 12 females and 2 males. The cases fall into two groups: (*a*) 12 cases treated with radium needles; (*b*) 2 cases treated with radon seeds.

a. Radium needles were inserted from the vagina, perineum, or peri-anal skin in 12 cases, with the following results: 2 cases are alive and well for periods of 3 years 2 months (with colostomy) and 2 years 10 months (without colostomy) after the operation. The following are the details of these two cases:—

Case 1.—Female, age 60. Movable fungating tumour in lower third of rectum, situated anteriorly and on the left side. October, 1928—31 radium needles, total 22·1 mgrm., inserted for 68 hours; dosage 1502 mgrm. hours. November, 1928—left inguinal colostomy. December, 1928—second radiation carried out, 5 needles totalling 12 mgrm. being inserted from outside the anus for 152 hours; dosage 1824 mgrm.-hours. April, 1929—third radiation, partly via lumen of bowel, partly from outside; dosage 2688 mgrm.-hours. July, 1929—re-admitted for treatment of radium burn of anal canal and removal of a slough from the left ischiorectal fossa. The patient made a gradual recovery, and in December, 1931, reported that her health was good and that she had no symptoms of recurrence.

Case 2.—Female, age 61, with a small, hard malignant tumour on the right lateral wall of the lower rectum. The diagnosis of adenocarcinoma was proved by microscopical examination of portions of the growth removed with Brünings' forceps. The patient was a stout bronchitic subject unsuitable for radical operation. In May, 1929, interstitial radium needling was carried out by separate punctures external to the anus and per vaginam—total 26 mgrm. for 10 days; dosage 6240 mgrm.-hours. Colostomy was not performed. The new growth retrogressed very rapidly. The patient is now in good health and free from rectal symptoms; her bowels act normally. The site of the original tumour in the rectum is marked by a smooth, depressed scar without any outlying induration. Abdominal examination is negative.

Three cases are alive, but with symptoms of recurrence, 2 years 2 months, 2 years, and 1½ years (all without colostomy). One case died with pleurisy, jaundice, and ascites three months after interstitial needling of an operable adenocarcinoma.

Six cases subsequently required perineal excision for the following reasons: (i) Three for lack of response to radium; one of these cases had two further applications of radium or radon before excision was decided upon, and one case had one further radium needling. (ii) One on account of finding a second growth higher up. (iii) Two for recurrence of the growth locally; the excision operation in these 2 cases being done twenty-one months after the initial radium treatment (both proved to be *C* cases). Four out of the 6 perineal excision cases are now alive and well, 2 years 3 months, 2 years 3 months, 6 months, and 3 months after operation. One is dead from secondary deposits in the lungs, and one died from mediastinal growth.

b. Two recent cases were treated by intrarectal radon seeds, one after colostomy and one after local excision of a small rectal cancer. Both are at present alive and well, the tumours having disappeared.

Commentary.—It is seen therefore that out of 12 operable cases treated with radium needles as the primary method of treatment there are only 2 good results achieved by radium alone. The fact that such results are capable of being achieved is important; it would be more useful still to know why these cases responded well and how such good results could be repeated. In 6 of the cases a trial of radium treatment had to be terminated by perineal excision and the loss of valuable time in these cases is evident. Attention should be directed to three of the bad results in this series of 12 cases.

i. Death from pleurisy and jaundice three months after interstitial needling of an early growth.

ii. Death from secondary deposits in the lungs fifteen months after perineal excision and nineteen months after the original interstitial radium needling per vaginam. The operation specimen was classified as a *B* case.

iii. Death from a mediastinal growth thirteen months after perineal excision. This case had previously received two treatments by radium needling nineteen and seventeen months before death.

The conclusion is almost forced upon one that these unusual results can only be explained by vascular embolism set up by the radium needling.

2. **Radium in Conjunction with Perineal Excision.**—In 11 cases treated by perineal excision, radium has been employed also, the indications being a suspected extension of the growth beyond the limits of the operation. The radium needles have been inserted into the upper part of the mesorectum, along the lateral ligaments, and into the base of the prostate.

There was one operative death on the tenth day; post-mortem examination showed a pelvic peritonitis to be present without any definite evidence of the source of the infection.

Of the 10 operative survivals, 5 were classified as *B* cases, 5 as *C* cases. One *B* case died three months after operation, probably from urinary failure; 3 *B* cases are alive and well for periods of 3 years, 3 years, and $1\frac{1}{2}$ years after operation; and 1 *B* case was alive and well at a year after the operation, and since then he has not been traced, as his work has taken him away from his home. Of the 5 *C* cases, 4 are dead from recurrence in less than 18 months after operation; 1 is alive 18 months after operation—his health is poor, and he is stated to have secondary malignant deposits in the iliac glands.

Commentary.—The conclusion is that in *B* cases radiation is unnecessary, and in *C* cases there is no evidence that the radium treatment was beneficial either in preventing recurrence or in otherwise assisting the treatment by operation.

3. **Abdominal Radiation.**—Abdominal radiation by radium needles or radon seeds has been employed in 16 cases: there were 15 cases of carcinoma and 1 case of sarcoma.

a. In 13 cases the patients had inoperable cancers of the rectosigmoidal junction. In 2 cases colostomy had been performed previously, in 1 case colostomy was performed when the radium was removed on the seventh day, in 1 case colostomy was not done, and in the remaining 9 cases colostomy was performed at the time of insertion of radium needles or radon. Operative death occurred in 6 cases; there were 4 deaths from peritonitis from the third to the eighth day after operation, 2 of these cases having

required also a resection of small intestine; 1 death occurred on the second day from intraperitoneal hæmorrhage, and 1 death on the twenty-fourth day from gradual failure. Of the 7 cases that survived operation, 5 died unrelieved at periods varying from 3 months to a maximum of 18 months after operation, and the following are the details of two of these cases :—

One case, a male, age 59, with an inoperable growth in the upper third of the rectum, was treated by colostomy and insertion of radon seeds intraperitoneally into the growth. Later, radon seeds were inserted into the growth intrarectally on two occasions, and fourteen months after the initial treatment sigmoidoscopy showed a smooth cavity, lined apparently by normal mucosa, without any sign of carcinoma locally. The patient, however, died eighteen months after the original operation, probably with secondary deposits in the liver.

One patient with a large inoperable growth in the upper third of the rectum was treated by colostomy and insertion of 22 mgrm. of radium, the needles being passed along catheters into and around the growth. Prolonged suppuration in the abdominal wall followed, and finally cystoscopy proved the growth to be infiltrating into the base of the bladder; the patient died unrelieved three months after operation.

The following are the details of the two cases that are still alive after abdominal radiation for inoperable cancers in the upper one-third of the rectum :—

Case 1.—Male, age 70, with a fixed carcinoma in the upper one-third of the rectum was treated in April, 1929, by colostomy and intraperitoneal insertion of 11 mgrm. of radium. Five weeks later sigmoidoscopy showed a marked radio-reaction, with diminution in size of the growth with less hardness and fixity. In November, 1929, five radium needles (each 2 mgrm.) were inserted into the growth intrarectally. In December, 1931, i.e., more than two and a half years after the original operation, he reported himself as being in good health and able to do gardening.

Case 2.—Male, age 47, with an inoperable growth in the upper third of the rectum was treated in August, 1929, by colostomy and intra-abdominal radium. Later, radon seeds were inserted per sigmoidoscope twice. In December, 1931, he was reported to be alive, but in very poor health, with recurrent symptoms.

b. The three remaining cases fall into different categories :—

In one, a female, age 58, a perineal excision of the rectum was performed on account of an ulcerated tumour in the lower third of the rectum, with massive, upward lymphatic spread. Section proved the growth to be a round-celled sarcoma. Six weeks later laparotomy was performed and 17 mgrm. of radium were inserted into the root of the pelvic mesocolon for ten days. Three months later a perineal recurrence was treated by interstitial needling. The patient died from the disease seven months after the excision operation, a rapidly growing subcutaneous nodule in the back proving that vascular embolism had taken place.

One case, a male, age 62, had a pedunculated malignant adenoma, the size of a hazel nut, avulsed per sigmoidoscope from the rectosigmoidal junction, accompanied by intraperitoneal insertion of five 0·5-mgrm. radium needles into the related portion of the mesorectum for nine days. The

patient reported himself to be well and free from symptoms two and a half years later. There is no definite proof, however, that this very early carcinoma was not completely removed by the local excision.

One case, a female, age 61, had a carcinoma of the pelvic colon removed by Paul's operation, with insertion of radium down to the pouch of Douglas on account of definite subperitoneal nodules. Eleven months later multiple secondary deposits were present and the patient died seventeen days after a short-circuiting operation to relieve obstruction.

Commentary.—The intra-abdominal method of radium treatment for inoperable rectal cancers is shown by this series to be attended with a high operative risk, and the late results do not appear to justify the added risks when compared with the results of simple palliative colostomy.

4. **Posterior Barrage.**—Radium needling by posterior barrage has been carried out in 9 cases. In 3 the needling was done without a previous colostomy, in the remaining 6 a colostomy had either been established prior to the radium barrage or was effected at the same time.

Three patients died from post-operative toxæmia on the fourteenth, thirty-eighth, and forty-fifth days after operation. One patient died from recurrent secondary hæmorrhage from the perineal sinus three and a half months after operation. One had a severe hæmorrhage from the colostomy eight months after the operation and finally died from secondary growth two years after the radium insertion. One patient died nine months after operation, and one is untraced. The following are the details of the two cases that are known to be alive :—

Case 1.—Male, age 66, with a large rectal carcinoma adherent to the sacrum. Radium needling by posterior barrage was carried out in July, 1929 (38 mgrm. for 7 days = 6384 mgrm.-hours). Colostomy was not done. Rapid retrogression occurred, and in November, 1929, the rectum was smooth without any sign of tumour formation. In December, 1931, he reported that he was in very good health and able to do office work.

Case 2.—Female, age 53, with a large, fixed ulcerated growth in lower third of the rectum. Oct. 3, 1930—left iliac colostomy. Oct. 21—posterior and anterior radium barrage (52 mgrm. for 7 days = 8736 mgrm.-hours). The patient made a slow convalescence and in March, 1931, she had gained weight, and the rectum presented a smooth stricture, without any sign of neoplasm. In February, 1932, the condition was unchanged, there being a marked fibrous stenosis of the rectum, free from ulceration.

Commentary.—There are thus 2 good results in a series of 9 cases. The dangers of the method are evident and are indicated by the fact that 3 of the cases required hospital treatment for more than three months after operation, on account of severe wound sepsis.

5. **Interstitial Needling for Inoperable Adenocarcinoma of the Rectum.**—Eighteen cases (8 males, 10 females) have been treated by interstitial needling from the perineum, peri-anal circumference, or vagina : 7 cases were treated without colostomy and 11 cases had a colostomy performed previous to operation.

There was one operative death from toxæmia on the 13th day (male, age 56). Six cases died unrelieved at periods varying from 5 weeks to 2 years after the radium treatment, and 1 other case at present untraced

probably died 2 years after operation. Four cases have been much relieved and are now free from rectal symptoms 14 months, 16 months, 18 months, 18 months since operation. Two of these cases have colostomy, and 2 were treated without colostomy. Four cases have been relieved, but still have rectal symptoms 8, 9, 15, and 19 months later, and 2 cases are recent.

Commentary.—This type of radium needling evidently has a smaller operative risk as compared with the posterior barrage operation, but even so several cases passed through a long period of post-operative suppuration, with necessity for incision of perirectal abscesses and slow removal of sloughs. Two females developed rectovaginal fistulæ.

6. Radium for Recurrent Carcinoma.—

a. Seven cases of local recurrence in the perineum, vaginal wall, or ischio-rectal fossa, occurring at varying times after perineal excision, have been treated by interstitial radium needling. Five of these cases have died unrelieved at intervals of 4, 5, 7, 8, and 15 months after the radium treatment. One case is alive 20 months after radium was first applied to a perineal recurrence. Radium has recently been re-inserted for the third time and tissue removed from the margins of the ulcer has been shown to contain deposits of adenocarcinoma which are well differentiated and actively proliferating. One case treated in October, 1931, is at present relieved.

b. Two other cases of recurrent carcinoma need separate mention.

Case 1.—Female, age 54, with a small operable carcinoma low down in the anterior rectal wall. In May, 1930, the growth was excised locally. One month later the scar was found to be slightly nodular, and the scar was irradiated by vaginal needling. In November, 1931, she was examined and found to be free from recurrence.

Case 2.—Female, age 55, with a mass of abdominal recurrence eight years after perineal excision of the rectum. In October, 1928, abdominal implantation of radium into the pelvic mesocolon was carried out. The patient died in February, 1930.

Commentary.—These results suggest that there is very little likelihood of an established recurrence being more than temporarily improved by interstitial needling.

II. SQUAMOUS CARCINOMA OF THE ANUS AND ANAL CANAL.

Twelve cases of this type have been treated by radium needles: of these 8 are assessed as 'operable', and 4 as 'inoperable'.

Operable Cases.—Of these 8 operable cases there have been 4 good results in which the anal carcinomas have completely disappeared as a result of the treatment, and colostomy has not been required. Three of the cases are alive and well at periods of 3 years, 2½ years, and 2½ years since operation, and the fourth case has recently died from bronchopneumonia 2 years after the treatment. His anal condition was subjected to careful examination shortly before his death and there was no sign of recurrence.

Of the remaining cases one was relieved for 6 months and then local recurrence became evident, with a very rapid extension to the groin, which

exploration proved to be inoperable: death occurred 10 months after the original radiation. One case was relieved for 6 months, when local recurrence occurred and an extensive carcinoma of the cervix uteri was found. She died about 15 months after the radium operation.

One case died unrelieved 3 months after operation. One case of carcinoma of the anal canal, treated by colostomy and interstitial needling, is recent; the growth has already retrogressed markedly.

Inoperable Cases.—Of the 4 inoperable cases treated, 2 have died unrelieved, each living for exactly one year. One patient with a squamous carcinoma of the rectovaginal septum was relieved for a year. Two further insertions of radium were done, with temporary relief, and she died finally 3 years and 2 months after coming under observation. One other case is probably alive but unrelieved.

SUMMARY.

1. The results of perineal excision of the rectum are shown, and the importance of Dukes' classification of rectal cancers is emphasized, for this method enables the early cases to be separated from the late cases. *Table IX* reveals the excellent results, both immediate and remote, that can be expected in Groups *A* and *B*, together with the bad prognosis in those cases in which metastasis has occurred to the regional lymph-nodes.

2. The feeling of uncertainty and disappointment which is felt in regard to radium in the treatment of rectal cancer is reflected in the following table showing the number of new cases submitted to radium treatment in the last four years.

Year	New Cases Treated with Radium
1928 (part only)	5
1929	44
1930	31
1931	9

In operable adenocarcinoma there have been two good results out of 12 cases treated: this is a poor showing compared with the results of perineal excision and accounts for the present opinion that radical operation holds out the best chance of cure to the patient.

The dangers of abdominal radiation and of posterior barrage have been sufficiently indicated. The futility of needling *C* cases at operation, and cases of recurrent cancer, is also evident. There is no case in this series in which an inoperable rectal cancer has been rendered operable by the use of radium.

The intrarectal insertion of radon seeds carries the least operative risk of the various methods of radium needling, but whether this form of radiation can produce anything better than a temporary palliation it is not yet possible to say from a study of these cases.

The most hopeful results have been obtained in the case of operable squamous carcinoma of the anus: this class of case having given 50 per cent of good results up to three years. This type of growth appears to respond

much better to radium than adenocarcinoma, but it must be taken into account that the growths are much more accessible and the needling can therefore be carried out more effectively.

This report has been compiled from the Cancer Follow-up Scheme of St. Mark's Hospital, which has been carried on under my direction for the last ten years with the help of an annual grant from the Medical Research Council. I need hardly say that my colleagues have always given their ready co-operation with the scheme, and I feel it a great privilege to present this comprehensive report on the results of our united efforts. The section dealing with the results of radium treatment is published with the permission of the Medical Research Council.

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DELAYED HÆMORRHAGE FOLLOWING TRAUMATIC RUPTURE OF THE SPLEEN.*

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Rupture of the spleen, whether traumatic or spontaneous, the result of perforating wounds or of subcutaneous injury, is usually rapidly fatal unless immediate operation is performed. There is, however, considerable variability in the evolution of the clinical signs, owing to the character of the internal hæmorrhage which dominates the symptoms of rupture of the spleen. As Bland-Sutton pointed out, the patient may collapse as dramatically as when an aortic aneurysm has burst. Vincent reported many instances in which death supervened in this manner. Thus, the accident may be brought into the category of those better-known conditions capable of producing sudden death, and should always be borne in mind in the investigation of such an occurrence, particularly if injury is recorded as having been sustained in the region of the spleen. From the therapeutic standpoint such cases are not of much interest. On the other hand, after the initial injury the patient's condition may gradually become worse, with obscure abdominal symptoms over a period of hours, days, or weeks, until the fact of progressive internal hæmorrhage becomes manifest and the surgeon's aid is finally sought. Particular significance is attached to the cases in which the clinical course is more prolonged, because of the too-often-forgotten fact that between the initial injury to the spleen and the appearance of signs of internal hæmorrhage there is usually a period of 'symptomatic silence' termed by Baudet the 'latent period'. This usually lasts from a few hours to one or two days and may lull the patient and physician alike into a false sense of security which may be rudely shattered by the rapid collapse of the patient under the cumulative effect of the active, internal hæmorrhage. Much more rarely this latent period exists for days or weeks and the patient goes about his work in the belief that the primary injury is not of much significance. The latent period in such cases is due to the absolute cessation of all bleeding from the injured organ and to its efforts at repair. It is terminated by the abrupt renewal of profuse secondary hæmorrhage under the stress of a slight rise in blood-pressure and is attended by the same high mortality as primary rupture unless operative intervention is immediately undertaken.

The occurrence of a typical example of the foregoing syndrome at the Mayo Clinic stimulated me to search for other examples, and, in view of the fact that adequate study of such cases has not appeared in English medical literature, I have collected and studied forty-six reports of cases from the

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literature, including the case which has been published in abstract by Counseller and me.[46] This case is reported in detail herein. It should be made clear that these represent examples of subcutaneous injury in which it was certain that primary rupture was followed by temporarily complete or almost complete cessation of hæmorrhage for a longer or shorter period, and this, by delayed bleeding of great severity. Since the latent period undoubtedly existed in cases in which hæmorrhage was still occurring I arbitrarily chose only those in which it lasted more than forty-eight hours and in which the clinical course undoubtedly indicated renewed secondary hæmorrhage. Furthermore, I have not included cases in which the patient gradually sank under the influence of a slowly progressive hæmorrhage and in which there was complete absence of the sudden collapse so typical of the particular syndrome I am describing. For this reason certain cases (d'Auvray,[3] Balloch,[5] Baudet,[7] Fiolle,[27] Hoffmann,[35] Metcalfe,[49] Neck,[51] Novis,[53] Page,[54] Rammstedt,[61] Stowasser[68]), including the second case of Flammer, could not be accepted in the series that I am presenting in review, although foreign authors have included them in their tabulations. Six cases were included in which the details were meagre but no doubt existed as to their nature (Bland-Sutton,[11] Freund-Kirchner and Doyle,[30] Heuss,[34] Krüger,[40] Swynghedauw and Gaudier[72]).

CASE REPORT.

History.—A man, aged 45 years, ten days previous to his admission to the hospital, while felling trees had been struck a glancing blow in the left upper abdominal quadrant by a branch of a falling tree. He insisted that the blow was of moderate severity, that he was not knocked down, and that no external injury resulted. Almost immediately, however, he experienced violent pain in the left upper quadrant which lasted about ten minutes. He was then able to continue work although slight pain persisted for the remainder of the day. In the night it again became severe, and the next day he consulted his physician. By that time the pain had practically disappeared and nothing of note was found on examination. Accordingly he worked for seven days, although he still complained of continuous nagging pain in the injured area. On the morning of the ninth day after the original injury he was suddenly seized with a violent exacerbation of the same pain, this time extending through to the back and up to the left shoulder. He became nauseated but did not vomit. He had considerable pain on deep inspiration at the base of the left lung. Within a short time he collapsed. In the previous nine days he had not noticed fever or any urinary abnormality. The previous history was entirely negative.

On Admission.—When admitted to the clinic the man was gravely ill; his skin was pale and covered with cold sweat, his eyes were lustreless, and his attention wandering. His respiration was rapid, grunting, and purely costal; his knees were flexed on his abdomen for greater comfort. The pulse-rate was 100 and the temperature 99·2°; the blood-pressures were 140 and 80 (normal blood-pressure 200 systolic). The diaphragm was elevated on both sides, particularly on the left, with fluid at the left base and moderate bronchopneumonia on both sides. There was suspicious tympany in the left side of the thorax, which rather suggested the possibility of a diaphragmatic hernia.

The abdomen was generally rigid and tender, especially in the left upper quadrant, where an indefinite mass could be felt, which was dull to percussion, from the seventh costal cartilage to the level of the umbilicus. The dullness did not shift. Rectal examination was negative. The urine was normal. The hæmoglobin was 48 per cent; erythrocytes numbered 2,720,000 and leucocytes 25,800; the differential count was negative. A diagnosis was made of concealed abdominal

hæmorrhage probably from ruptured spleen and possibly left-sided diaphragmatic hernia. The patient was observed for twelve hours, and the severe dehydration was combated by solutions of saline administered subcutaneously. The next day it was obvious that the patient was worse and operation was performed.

OPERATION.—Under local and ethylene anæsthesia the abdomen was opened by a wide transverse incision in the left upper quadrant. Blood was immediately encountered inside the peritoneum. Further exploration revealed a huge hæmatoma, consisting of old black clots and recent hæmorrhage, extending over the stomach from the transverse colon below to the left dome of the diaphragm above. It probably contained about 2 litres of blood. A piece of spleen was next encountered about 8 cm. in diameter, attached by a fragment of capsule to what was taken to be the remains of the pedicle of the spleen. There were no blood-vessels, however, to be noted in this fragment of capsule. The remainder of the spleen, in five separate pieces, was found loose in the blood-clot and held together by it. The splenic pedicle appeared to be entirely free, but active hæmorrhage was not occurring from it. The whole mass was quickly removed from the abdomen and three clamps were placed across the splenic pedicle as a protective measure. A few bleeding veins on the greater curvature of the stomach were ligated. The cavity was packed with iodoform gauze and the abdomen was closed. The patient was given a transfusion on the table of 500 c.c. of citrated blood, and immediately was placed in an oxygen tent, where he remained forty-eight hours. The clamps were removed at the end of this time and the packing was removed in seven days. Convalescence was uneventful, and the patient was up and about on the sixteenth day after operation.

PATHOLOGY.—Section of the largest of the five fragments of the spleen showed such extensive subcapsular hæmorrhage that almost the entire capsule had been

FIG. 99.—Spleen in five fragments as removed from the perisplenic hæmatoma. Note the extensive subscapular extravasation of blood. The lighter area of the largest piece represents normal spleen.

stripped up and separated from the subjacent parenchyma by uniform firm layers of partially organized blood-clot from 0·5 to 1 cm. thick; this process was observed in each fragment of spleen (*Fig.* 99). There also appeared to be some deeper parenchymatous hæmorrhage with evidence of thrombosis and early scattered infarcts. In other places perfectly normal splenic pulp could be seen. The ruptured surfaces seemed to be of more recent origin, owing to the lack of organizing blood-clot.

Microscopic examination of the intrasplenic blood showed definite attempts at organization with numerous fibroblasts and endothelial loops sprouting from the normal splenic pulp to invade the extravasated blood-clot (*Figs.* 100, 101). The amount of organization which had occurred was compatible with a lesion of eight

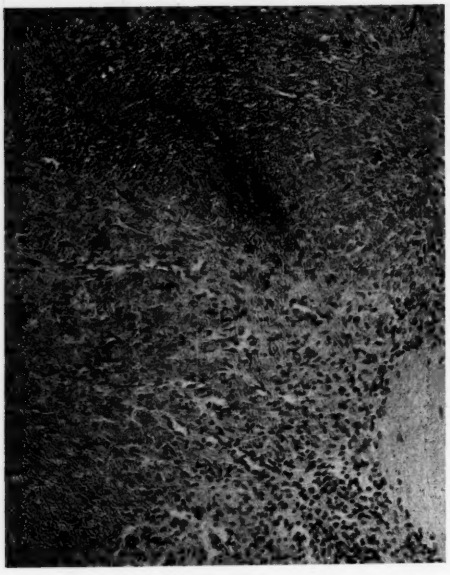

FIG. 100.—The edge of the intrasplenic hæmatoma. Active organization is proceeding. Endothelial buds and fibroblasts can be seen invading the blood mass from the adjacent splenic tissue. (× 110.)

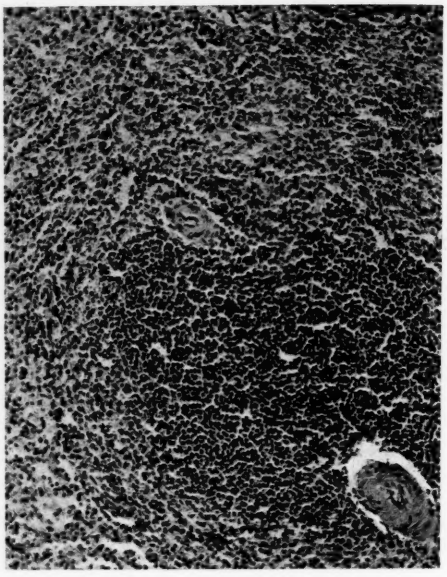

FIG. 101.—Normal spleen in a section taken from the centre of the fragments. (× 110.)

FIG. 102.—Subcapsular hæmatoma. Some splenic tissue is left attached to the capsule during the stripping process. The capsule is in reality forcibly torn from its attachment and not stripped. (× 100.)

to ten days' duration. On the other hand, the blood from the perisplenic hæmatoma was of much more recent origin; organization was not observed here. A small layer of normal splenic pulp was attached to the capsule torn away by the hæmorrhagic extravasation (*Fig.* 102). It appeared clear that this injury was an example of the formation of a primary intracapsular hæmatoma with extensive subcapsular hæmorrhage followed by attempts at healing over a period of eight days. Repeated slow hæmorrhages, however, had apparently increased the intracapsular tension to the point at which a slight rise in intra-abdominal or intravascular pressure had caused secondary capsular rupture of explosive violence which shattered the spleen entirely and blew it off its pedicle. The huge perisplenic hæmatoma was then formed. No doubt, the profuse bleeding which followed the secondary rupture aided materially in further disintegrating the organ.

CLINICAL FEATURES.

Age and Sex.—The spleens of males are more likely to be injured than those of females, since in the active period of life males are more subject to blows, bumps, falls, and kicks. The youngest patient on record was aged 8 years, and the oldest 63. Most of them were between the ages of 15 and 50. Only 4 of the 46 patients were women. Schlegel observed that if free blood is found on opening the peritoneum of a male patient, rupture of the spleen should first be considered. This takes into consideration the fact that spontaneous rupture of the abnormal spleen is by no means uncommon. Ruptured ectopic gestation should be considered in women.

Initial Injury.—It is well known that a patient who presents the usual signs of ruptured spleen has almost always suffered an accident of great severity, although notable exceptions to this rule occur. The reasons for this may be sought in the anatomical position of the viscus. The spleen is freely movable on its pedicle; it is protected by the elasticity and cushioning effect of the neighbouring viscera and lies hidden beneath the ribs so that it is adapted to resist external violence and to retreat before shocks and blows. The evidence for the severity of the violence required to produce rupture of its capsule is to be found in the frequency with which neighbouring structures are coincidentally involved. One may, therefore, surmise that the force which produces uncomplicated rupture of the normal spleen is usually sudden, severe, and localized to the splenic region. In the so-called subcutaneous injuries, besides the effect of the direct blow, the organ is hurled suddenly against the vertebral column and crushed or ruptured by contrecoup violence. This explains the frequency of involvement of the hilum and consequent profuse hæmorrhage. If the spleen is pathologically enlarged it no longer lies protected, but projects forward directly beneath the anterior abdominal wall, where it is exposed to blows. The friability of the pulp, its extreme vascularity, the brittle nature of the capsule from hyaline perisplenitis, and the frequent fixation of the organ to the parietal walls make it exceedingly vulnerable to external trauma. Under such circumstances the slightest increase in intra-abdominal pressure, such as that caused by coughing, vomiting, bending, or straining at stool, may be sufficient to burst a splenic vessel. So-called spontaneous rupture of the spleen, a common abdominal catastrophe in malarial regions, is explained in this way. The same accident has been reported in leukæmia,[33] ulcerative endocarditis,[38] typhoid and typhus fever, influenza,[26]

and carbuncle.[22] Wild reported the cure of a hæmorrhagic diathesis (apparently essential thrombocytopenic purpura) following splenectomy for spontaneous rupture of the spleen. In connection with such spontaneous ruptures Camus quoted the aphorism of Besnier to the effect that "traumatism plays a part in spontaneous rupture of the spleen and the spleen is ready to rupture when the trauma occurs."

The initial injury to the spleen in this condition, however, is of necessity comparatively slight, for temporary recovery from it always occurs within a short time. In 44 cases in which the primary injury was recorded, 20 accidents were severe, 16 were moderately severe, and 7 were slight; in 1 case rupture apparently was spontaneous. In all but one, the force of the blow was directed against the base of the left side of the thorax or the left upper abdominal quadrant. The single example of indirect injury was furnished by Hahn's case, in which the patient was thrown violently to the ground, striking the right side of the abdomen.

The symptoms produced by such accidents varied with the severity of the injury. The preponderance of the complication of fractured ribs over all others (10 cases), especially those of the lower left side, should always arouse suspicion of subjacent splenic injury. More often than not, the associated injuries completely masked the underlying condition. As almost invariably happens when the abdomen receives a severe blow, the patient immediately suffered from a varying degree of traumatic shock. Dizziness, faintness, weakness, nausea, and vomiting, or even complete collapse associated with rapid pulse, pallor, clammy skin, cold extremities, and shallow respiration, were noted. Recovery from this in favourable cases occurred in twelve or fifteen minutes, and the patient could then be helped to his home, or he walked to the nearest hospital. Sometimes he was even able to go about his affairs. If the injury was slight or only moderately severe, these general symptoms were usually entirely absent, so that within a few days all recollection of the accident had passed from the patient's mind. In this connection one might speculate on whether the seven remarkable cases of spontaneous rupture of the normal spleen reported by Susman and others were not in reality examples of secondary hæmorrhage following accidents which had entirely escaped the patient's notice.

The closest attention, however, should be paid to the local symptoms and signs, for these furnish the only definite evidence of splenic injury. Pain over the region of the spleen was a complaint in almost every case. It varied in intensity from mere discomfort or dull aching to severe stabbing paroxysms of great intensity forcing the patient to lie down until relief was obtained. Once only did the pain radiate to the left shoulder. Possibly careful questioning would have elicited this symptom more often, for its significance in lesions in the vicinity of the diaphragm cannot be exaggerated. Abdominal rigidity, generalized at first, but more often localized to the epigastrium or to the left upper abdominal quadrant, was the commonest sign, and was associated with a varying degree of tenderness both here, in the left costovertebral angle, and at the base of the left side of the thorax (*Fig.* 103, 1). Rigidity in abdominal contusions not limited to the injured point is of paramount diagnostic significance and is a clear indication for immediate laparotomy. Suspicion of

underlying injury to the spleen should therefore always be entertained in spite of the presence of other injuries if after such an accident persistent abdominal rigidity is found in the left upper abdominal quadrant. In a certain number of cases in this series symptoms or signs were not present, beyond a little discomfort or dull ache in the left side, but the spleen had undoubtedly ruptured. Diagnosis in such cases was manifestly impossible. The patients would seem to be in great danger from the almost inevitable

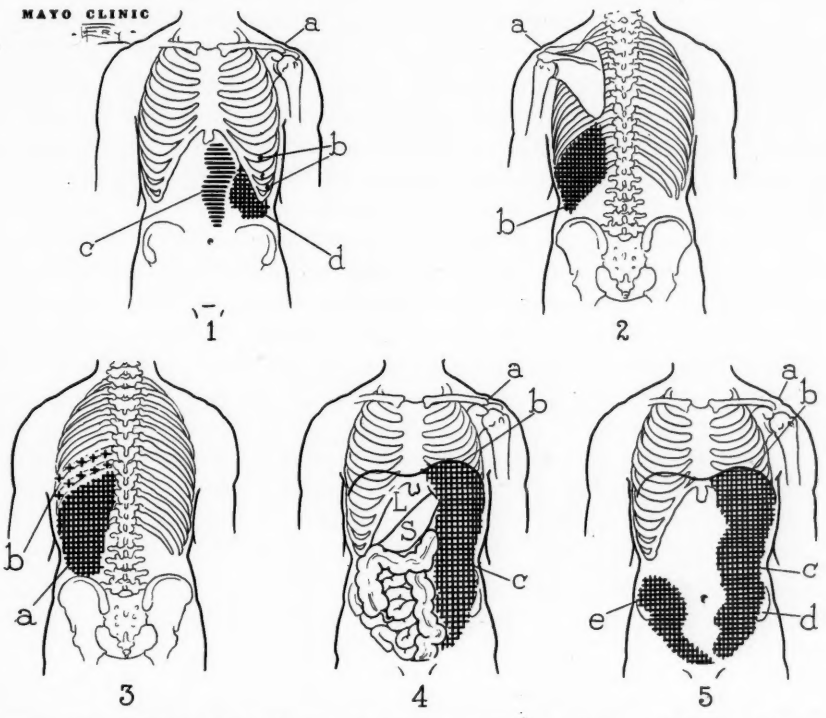

FIG. 103.—1, The initial injury; no increase in splenic dullness: (*a*) Reflex pain in the left shoulder; (*b*) fractured ribs; (*c*) left upper abdominal rigidity; (*d*) pain and tenderness. 2, The initial injury; slight increase in splenic dullness posteriorly; probably capsular rupture with perisplenic hæmatoma: (*a*) Reflex pain in shoulder; (*b*) increased splenic dullness. 3, Secondary rupture: (*a*) Large perisplenic hæmatoma from posterior aspect; (*b*) occasional involvement of left lung and pleura through diaphragm. 4, Secondary rupture; large perisplenic hæmatoma from anterior aspect showing displacement of organs: (*a*) Pain in shoulder; (*b*) elevation of diaphragm; (*c*) perisplenic hæmatoma. 5, Secondary rupture; large perisplenic hæmatoma spilling over into peritoneal cavity: (*a*) Reflex pain in left shoulder; (*b*) elevation of diaphragm; (*c*) perisplenic hæmatoma; (*d*) fixed dullness; (*e*) shifting dullness.

secondary rupture, for when it occurs they are likely to be far from medical aid.

The duration of the disability occasioned by the initial injury depended more on the associated injury than on splenic trauma and the cessation of subcapsular or perisplenic bleeding. Many subjects returned to work in one or two days, while a few complained of acute symptoms referable to the traumatized spleen for only a few hours. Most patients did not return to work entirely free from symptoms, but they were able to work.

Latent Period.—In the group of cases in my review the latent period began with the cessation of splenic bleeding and was terminated by the abrupt onset of secondary bleeding at a date remote from the primary injury. In the usual case of rupture of the spleen the swift appearance of the signs of internal bleeding does not coincide with the onset of a fresh, fulminating hæmorrhage but represents either the rapid failure of the patient's resistance against an internal hæmorrhage, profuse and continuous from its onset, or collapse, following the sudden evacuation of a constantly augmented perisplenic hæmatoma into the general peritoneal cavity. This rather short intervening period is to be distinguished from the true latent period in that here all bleeding has ceased and the interval of comparative symptomatic silence is prolonged. The shortest period was forty-eight hours, the longest six months. As may be noted in *Table I*, hæmorrhage occurred most often between the third and ninth days, rarely after the fourteenth day.

Table I.—Frequency of Secondary Rupture according to Latent Period.

Latent Period	Cases
2–6 days ..	23
7–11 „ ..	12
12–16 „ ..	4
17–21 „ ..	3
22–26 „ ..	1
26–30 „ ..	1
More than 30 „ ..	1

During the latent period an excellent opportunity may be afforded of confirming a suspicion that the spleen is ruptured, of guarding the patient against secondary hæmorrhage, or even of operating before it occurs. Many authors have observed that although complete freedom from all symptoms was occasionally undeniable, in certain cases symptoms did exist but escaped notice because the patient did not complain of them. Even though patients were attending to their daily affairs, absolute symptomatic silence was far from the rule. The two elements of most significance were persistence of a dull remittent or exacerbating pain in the left side and of slight rigidity in the left upper abdominal quadrant (*Fig.* 103, 1). The latter was provoked by the slightest examination and was occasionally present when the pain was minimal. Repeated examination was often necessary to be sure of its presence. It was Perrin's belief that if the rigidity increased, a more serious lesion than simple contusion should be suspected. Less frequently slight acceleration of the pulse-rate was demonstrable (80 to 100), but this was noted only if a perisplenic hæmatoma had formed at the primary rupture.

Costal breathing was mentioned by several writers, and, as in Strauss's case and in mine, signs of left basal pleurisy or pneumonia were suggestive. Fever was distinctly uncommon, but the leucocytosis of hæmorrhage was not infrequent. In a few instances more definite signs indicated the existence of a perisplenic hæmatoma, such as fullness in the left hypochondrium and an increase in splenic dullness associated with slight pallor, weakness, dizziness, and occasional fainting spells (*Fig.* 103, 2). These, however, were more characteristic of the cases in which bleeding was slowly progressive, the patient gradually going from bad to worse. Percussion is of relatively little value in determining the size of the spleen. Normally there is dullness in the mid-axillary line from the ninth to eleventh ribs corresponding to that part of the organ which is most superficial. Its anterior edge of dullness is approximately in the anterior axillary line. If this is enlarged upward and forward beneath the anterior abdominal wall, or downward posteriorly below the eleventh and twelfth ribs, it is probable that a small perisplenic hæmatoma is present.

Secondary Splenic Rupture and Delayed Hæmorrhage.—The abrupt onset of delayed hæmorrhage immediately constituted in all cases a grave abdominal disaster, made more serious by the apparent lack of an adequate cause, by the difficulty in diagnosis, and by the fulminating character of the bleeding. The time of onset—forty-eight hours to six months after the initial injury—apparently had nothing to do with the physiological state of contraction or expansion of the spleen. In several cases it occurred while the patients were going quietly about their affairs without effort. On the other hand, it took place several times just after slight strain, such as that attending defæcation, pulling on socks, and so forth. Very little was required to break down whatever protective barrier might have formed around or within the injured organ; sometimes a slight effort produced it, but just as often it was apparently spontaneous. It took place as soon as the intrasplenic vascular pressure was too great for the weakened splenic tissue and perisplenic adhesions to sustain it.

The onset of hæmorrhage was almost always followed by the same characteristic train of symptoms. A sudden agonizingly severe attack of pain was felt, usually in the left side or more diffusely in the abdomen, and associated with abdominal rigidity, tenderness, and a varying degree of shock even to complete loss of consciousness, pallid sweating skin, cold extremities, rapid feeble pulse, and unobtainable blood-pressure. Death occurred with startling rapidity in seven cases before anything could be done. Such an event taking place just after the patient had been allowed out of bed was suggestive of pulmonary or mesenteric embolism or coronary thrombosis.

If the patient survived the initial collapse, the diagnosis of severe internal hæmorrhage was not long in doubt, unless the short subsequent period of improvement already mentioned made added difficulties. Increasing pallor and weakness, rising pulse and falling blood-pressure, dyspnœa and costal breathing, with nausea and vomiting, were almost constantly found. If the blood was examined in the laboratory, a marked drop in hæmoglobin and in the number of erythrocytes, combined usually with a sharp rise in leucocytes, occurred. The simultaneous occurrence of abdominal rigidity and tenderness,

with increasing dullness in the left side or in both flanks, usually made it clear that serious intra-abdominal hæmorrhage was occurring. Distinct fullness in the left hypochondrium sometimes amounting to a definite mass was occasionally noted. In my own case W. J. Mayo called my attention to the sensation of doughiness or soft lumpiness imparted to the examining hand from the presence of firm clots in the hæmatoma. Such symptoms were of course entirely sufficient to justify immediate abdominal exploration, but they offered little help as to the source of the hæmorrhage, a point of considerable significance in placing the exploratory incision. Pitts and Ballance stated that a splenic origin could be deduced " from the locality of the injury, from the evidence of internal hæmorrhage, from the great increase in fixed dullness in the splenic region, and from the fact that though both flanks were dull on percussion the right flank alone became entirely resonant on change of position."

The value of 'Ballance's sign', as it is now called, has been questioned by several observers because typical signs of free fluid were repeatedly obtained in this condition. It seems obvious that the sign could be elicited most easily during the period of expansion of the splenic pouch by blood, and while the growing perisplenic hæmatoma was localized. At some time during the evolution of this clinical picture it should be found.

Pain in the left shoulder referred from the splenic region was noted in several cases. Its occurrence is probably more frequent than is generally believed, owing to the ease with which it is overlooked. Another observation of considerable assistance in the diagnosis was elevation of the left diaphragm from the pressure of the subjacent hæmatoma. Naturally in such emergency little time is given for the taking of skiagrams of the thorax. So far as I know, skiagrams were not made in any case except mine (*Fig.* 103, 3, 4, 5).

Atypical symptoms were occasionally noted. Thus in Perrin's second case the perforation of a hollow viscus seemed responsible. The same diagnosis was made in Stolze's case. An even more marked example of this occurred in Eisenklam's case, in which the abdominal pain, tenderness, and rigidity were all on the right side. In Wohlgemuth's case the patient appeared to have suffered rupture of a Fallopian tube, because the pain was low on the left side and the initial injury to the spleen was not recognized before operation.

In general one might state that the diagnosis may be made from a knowledge of the injury and the site of the primary injury ; from the presence of a persistent dull ache in the left side with slight left upper abdominal rigidity during the latent period ; from the later sudden onset of signs of severe internal hæmorrhage, and in conjunction with the appearance of Ballance's sign, elevation of the left diaphragmatic dome, or pain in the left shoulder referred from the splenic region.

PATHOLOGICAL FEATURES.

Initial Injury.—Almost an exact parallel may be drawn between this condition and that of ectopic pregnancy, in which delayed hæmorrhage is notoriously common. Except for the fact that trauma produces in the spleen

what occurs spontaneously in the tube, the pathological evolution of the perisplenic hæmatoma and the pelvic hæmatocele is almost identical. Both, however, for anatomical reasons differ greatly from retroperitoneal hæmatoma resulting from such injuries as ruptured kidney. In contradistinction to the so-called spontaneous rupture of the spleen, predominantly an affection of the pathological organ, this accident occurred almost exclusively in the normal spleen (*see Fig.* 102). Of the 46 cases, malaria was present in only 2. The primary injury to the spleen may be classified in three groups: (1) Minor superficial capsular rupture or slight splenic contusion producing parenchymal ecchymosis; (2) Intrasplenic hæmatoma and subcapsular hæmorrhage without capsular rupture; and (3) Capsular and parenchymal rupture with perisplenic hæmatoma.

Minor superficial ruptures of the capsule or slight contusions of the spleen are probably not so rare as is generally believed, but they are undoubtedly far from common. They are merely small fissures in the capsule with little, if any, involvement of the subjacent parenchyma, and although they may be the cause of abundant hæmorrhage, usually they are not. Indeed, bleeding may be slight. Collin has called such lesions 'dry ruptures'. This is particularly the case if the lesion is situated on the convex surface of the spleen. What determines the severity of the hæmorrhage is not the depth of the rupture but the importance of the vessels sectioned. Thus fissures in the neighbourhood of the hilum are much more likely to produce severe hæmorrhage than in any other situation, and furthermore they show the least tendency to localization.

Splenic contusions consisting of small ecchymoses in the subcapsular region but without any extensive disorganization of the parenchyma or localized formation of hæmatoma are also in the main of minor significance. They undoubtedly heal rapidly, leaving scarcely any appreciable trace of their existence beyond a little scarring of the capsule or localized perisplenitis with adhesions.

Splenic contusions and superficial tears, unless they involve the hilum, tend toward spontaneous cure by simple scar formation. Although it is difficult to determine how many secondary hæmorrhages followed such superficial lesions a careful consideration of the cases in this series leads me to the conclusion that few, if any, occurred. Most of the primary injuries were of a somewhat more serious nature.

In most cases of intrasplenic hæmatoma and subcapsular hæmorrhage without rupture of the capsule, if the spleen was studied after operation or at necropsy, it was noted that diffuse or localized subcapsular hæmorrhage or more deeply placed hæmatoma formation was perhaps the most striking feature of the condition. If it was well marked where the capsule remained intact it was less obvious where intrasplenic tension had been relieved by fracture of the capsule at the primary injury. In about half of the cases microscopic examination showed that intrasplenic bleeding occurred before the initial rupture of the capsule, and was therefore to be regarded as the primary lesion. In the remainder of the cases some degree of concomitant rupture of the capsule had occurred, and the intrasplenic hæmatoma, if present, was associated with a larger or smaller perisplenic hæmatoma, the

evolution of which will be considered later. If the capsule remained intact, however, the trauma apparently produced true subcapsular or parenchymal rupture, giving place to a hæmorrhage whose tendency to assume large proportions was limited only by the tensile strength of the capsule. The resulting extravasation of blood into the place where the spleen pulp was broken contained in addition an admixture of pulp débris lying in a network of partially ruptured and stretched trabeculæ. The walls were ragged and irregular and were infiltrated with blood for a considerable distance from the hæmatoma itself.

In six cases (Ganguli,[31] Lejars,[41] Lempriere,[42] Pitts and Ballance,[59] Schlegel,[64] Swynghedauw and Gaudier[72]) the hæmatoma took the simplest form of a fairly well localized cystic mass, the so-called blood cyst, and produced a distinct purplish bump on the surface of the organ. These cysts

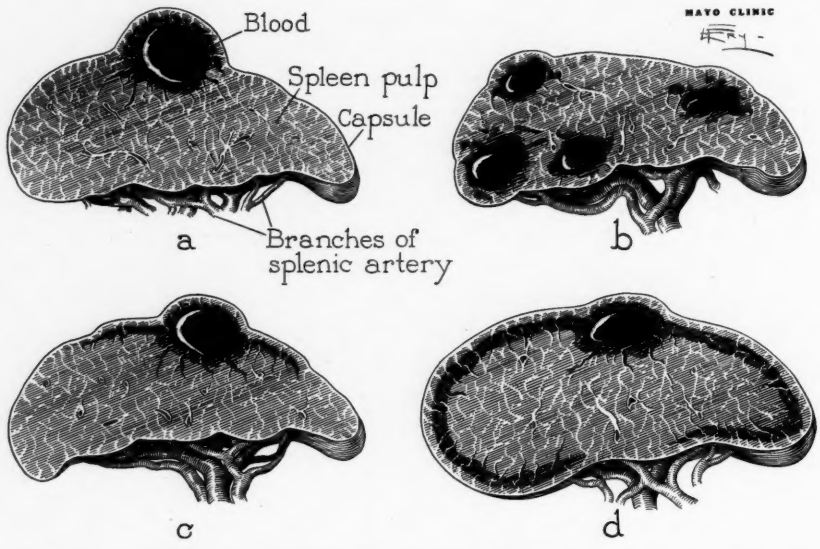

FIG. 104.—*a*, Intrasplenic hæmatoma—solitary 'blood cyst'; *b*, Multiple intrasplenic hæmatomata; *c*, Intrasplenic hæmatoma with moderate subcapsular hæmorrhagic extravasation; *d*, Intrasplenic hæmatoma with complete subcapsular extravasation.

varied in size from 2 to 8 cm. in diameter, and except for the case of Swynghedauw and Gaudier were single (*Fig.* 104, *a*, *b*). They were not situated in any particular part of the spleen, but seemed to acquire added hazards in the region of the vessels of the hilum.[31] In Lejars' case the whole spleen had been converted into a blood cyst by the complete disorganization of the parenchyma, and eventually it attained enormous proportions. In fifteen cases the original injury consisted of the same localized intrasplenic collection of blood, but here either by reason of its progressive burrowing capacity or because the subcapsular splenic pulp was particularly likely to be subjected to a tearing or crushing injury, the extravasated blood showed a marked tendency to spread laterally beneath the capsule and to lift it away from the subjacent parenchyma (*Fig.* 104, *c*). This was not true stripping of the capsule, but rather a tearing of the firm union which normally exists

between the fibrous splenic capsule and the trabeculæ supporting the pulp tissue. Some splenic tissue was thus left attached to the elevated capsule (*see Fig.* 102). The lateral extent of this hæmorrhagic extravasation varied from a few centimetres to complete separation of the capsule from the underlying pulp as far as the vessels of the hilum[15, 67] (*Fig.* 104, *d*). Why this area is so prone to hæmorrhagic extravasations is not known, but it is possibly related to the fact that this is the area of greatest movement of physiological volume. Lubarsch and Wolff assumed that this subcapsular area represents a 'flood region' of displacement of blood, and that injury is more likely to affect the organ in this region than elsewhere. The practical effect of the process was to increase enormously the area of the tensely stretched capsule, whose impaired nutrition would predispose toward secondary rupture. Whether the result of the primary injury was a single localized hæmatoma, multiple hæmorrhagic foci, or these two combined with extensive subcapsular extravasation, the cessation of bleeding depended entirely on the strength of the capsule. Splenic deformity and enlargement slowly progressed until the pressure exerted by the distended capsule equalized that produced by the extravasating blood. With the cessation of intrasplenic bleeding the patient entered the latent phase of the condition.

As has been pointed out, there was about an equal number of cases in which the predominating lesion was a frank capsular and parenchymal rupture with perisplenic hæmatoma. I am not considering here those cases in which the capsule alone was injured, but those in which more extensive involvement occurred. In many of these subcapsular bleeding developed at the same time, but since it was rarely so extensive as when the capsule remained intact, and as the secondary hæmorrhage was usually found to have occurred at the site of the already present rupture, this factor was not of great significance. The combined capsular and parenchymal ruptures were of every conceivable shape, size, and depth, and were not confined to any particular part of the organ, except so far as the concave surface was injured more frequently. Naturally the convex surface and posterior border were most commonly involved. The hilum as a site for secondary rupture was rather unusual, probably because any injury here involves important vessels which bleed furiously and show little tendency to localization. In many cases the lesions were multiple, both surfaces being affected. They varied from straight, curved, or angular to star-shaped, and extended into the parenchyma from a few millimetres to the entire thickness of the organ.

The rupture generally contained between its two surfaces a particularly fibrinous blood-clot attached to larger bloody masses which formed the perisplenic hæmatoma. Some amount of early cicatricial organization was usually apparent at the margins of the wound, the edges being somewhat indurated, covered with plastic lymph, and loosely adherent to surrounding organs, to omental tags, or to blood-clots. It was thus possible to estimate roughly the age of the rupture, particularly in relationship to any concomitant lesions as well as to the site of secondary hæmorrhage. The pathologic course of these primary rents in the spleen from the time of their infliction to the temporary cessation of bleeding depended on a number of variable factors. The more positive hæmostatic value of the capsule being here lost, other means

of controlling and localizing the resultant hæmatocele were utilized. To allow time for these less dependable agencies to swing into action, it is essential that the primary hæmorrhage be slow.

In many instances reference was made to the tamponading effect of clots between the two walls of the rupture (Buxton,[13] Jackson,[36] Kroner,[39] Neck,[51] Noetzel,[52] Wohlgemuth[77]). It was further noted, however, that in such a vascular organ as the spleen the weak fibrinous union which they produced between two such soft and friable surfaces offered little hope of efficient hæmostasis. With the spleen in his hand Perrin was able to observe how easily they might be dislodged and how easily bleeding might be recommenced. Old and recent perisplenic adhesions had probable value in limiting the expansion of the splenic pouch and in bringing such organs as the diaphragm, stomach, colon, or omentum into close apposition with the wound. Few, if any, adhesions could have existed before the primary rupture because in only two cases was there evidence of pre-existing pathologic processes. The

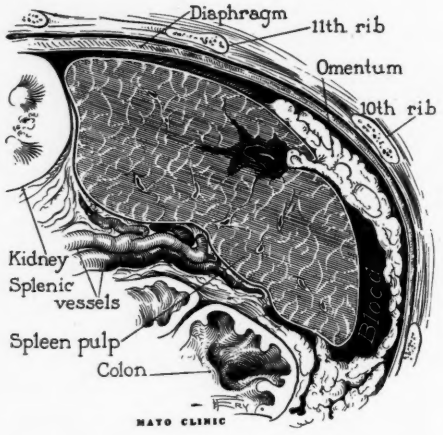

FIG. 105.—Capsular and parenchymal rupture with small perisplenic hæmatoma. Rent plugged with blood-clot and omental tongue.

frequency with which a tongue of omentum had insinuated itself between the margins of the rupture or had plastered itself over the wound was striking. The omentum itself was usually found to be blackened, swollen, and infiltrated with old blood. The early union was rather fragile,[57] but later was firmer and less easily separated. Omental plugging combined with the tamponading effect of the subjacent clots offers the most efficacious and most usual method of immediate and temporary hæmostasis (*Fig.* 105).

In addition to these hæmostatic agencies it is necessary to examine the anatomic disposition permitting the formation of a perisplenic hæmatoma, which either remains local or finally ruptures into the general peritoneal cavity. Constantinesco explained why a perisplenic hæmatoma may attain tremendous proportions before peritoneal inundation occurs. The spleen, like the Fallopian tubes but unlike the kidneys, is surrounded by a potential space bounded on all sides by organs or structures easily displaced so that a cavity capable of containing the entire volume of blood can be formed.

When the extravasation of blood took place at the primary rupture it rapidly surrounded the spleen, elevated the diaphragm above, from which respiratory symptoms occasionally arose, displaced the splenic flexure of the colon toward the iliac fossa, the stomach and intestinal coils to the right, the parietal wall of the left hypochondrium laterally and behind, and the omentum and the anterior abdominal wall in front. The presence of the gastrosplenic and gastrocolic ligaments and the mesocolon further aided in preventing the diffusion of blood to the right and above, whereas, as Trendelenburg has pointed out, reflex contraction of the anterior abdominal wall on the subjacent omentum and coils of small intestine greatly contributed to the localization of the hæmatoma anteriorly. Provided the hæmorrhage was reasonably slow, adhesions soon formed between the omentum and stomach, and the omentum and anterior abdominal wall, while the coils of small intestine and the omental tags of the colon stuck together in the vicinity of the hæmatoma. Thus the defensive reaction of the peritoneum by coalescence of the various organs which appeared more or less infiltrated with blood, produced an enclosure which did not permit diffusion of hæmorrhage and peritoneal flooding and aided materially in limiting further bleeding. Nevertheless, a true cyst was not formed and, with the exception of Lejars' case, trace of a capsule could not be found. These fibrinous adhesions were easily broken down. In few, if any, of the cases of primary hæmatoma was the tumour of large size, and in six only (Cohn,[18] Freund-Kirchner and Doyle,[30] Ganguli,[31] Kroner,[39] Noetzel,[52] Strauss[69]) was its presence manifested by clinical signs such as increased splenic dullness, Ballance's sign, or free fluid in the abdomen. The extravasated blood, at first fluid and of dark colour, rapidly coagulated to form a mass of black clots bathed in a considerable quantity of serum. Much of the latter undoubtedly seeped down through the peripheral adhesions to reach the pelvis and lower part of the abdomen and produced signs of free abdominal fluid. The liquid part of the hæmatoma soon became thick, syrupy, and brownish-red. Its resemblance to treacle was frequently noted.

Latent Period.—The time taken for hæmorrhage to cease probably varied largely with the type of injury. Thus hæmostasis would be more or less complete in intrasplenic lesions within a few minutes or hours. If extensive subcapsular extravasation was occurring, the process would be prolonged perhaps over a period of days, but at a much slower rate and probably intermittently after the initial immediate bleeding had been checked by the resistance of the capsule. Following capsular rupture and perisplenic bleeding, hæmostasis was more difficult to establish and maintain. It is obvious from the history of frequent attacks of left upper abdominal pain and tenderness with progressive weakness, anæmia, and slight increase in splenic dullness during the latent period, that sometimes fresh bleeding occurred intermittently and that the primary hæmatoma gradually increased in size. In most cases, however, hæmostasis was temporarily complete and the period of latency was occupied by attempts at healing. This phase of the question has been studied by Bland-Sutton, Englmann and Hitzler, and others. My case showed almost every stage of organization and repair, interrupted, it is true, by secondary rupture. Healing occurred by scar formation in the ordinary way. Fibroblastic proliferation of the splenic capsule, the trabeculæ, and

the adherent omentum sealed off the rent in the capsule concomitantly with the endothelial and fibroblastic invasion of the included blood-clot, thus replacing the earlier fibrinous adhesions by means of which primary hæmostasis was effected. The reticular and lymphoid elements of the parenchyma also showed marked proliferative activity. The same process was to be noted in the adhesions surrounding the perisplenic hæmatoma, these becoming consolidated by fibrous tissue infiltration. Struckhof observed the healing process in the spleen experimentally and has found it to be identical with what I have described.

In such a soft vascular organ as the spleen, and situated in such a locality, the balance maintained between the *vis a tergo* of the extravasating blood and the hæmostatic forces opposed to it was an exceedingly delicate one, for in all cases a little increase in the former was sufficient to bring about secondary rupture. The amount of trauma required has already been considered.

Besides the complication of delayed hæmorrhage, four varieties of termination of the healing process are recognized both in intrasplenic and perisplenic hæmatoma.

1. Complete absorption of the blood-clot and healing of the solution of continuity by scar tissue is more likely to occur if the initial injury is slight.

2. Apart from secondary rupture, encystment is undoubtedly the most common termination, especially if any subcapsular extravasation has occurred. The encysted hæmatoma or traumatic blood cyst acquires a fibrous-tissue capsule devoid of endothelial lining, whereas the contents gradually become serous, serosanguineous, or remain definitely hæmorrhagic. In practically every case blood pigment is a prominent feature of the walls of the cavity.

3. In certain rare cases, and then only in intrasplenic hæmatoma, the serum is absorbed, while the solid portion of the clot persists and becomes progressively harder. The primary hæmatoma is thus transformed into a firm mass of greyish-white tissue described under the name of 'fibrinous tumour of the spleen.' [14, 60]

4. Suppuration in the hæmatoma, also a rare complication, has occasionally been described.

Secondary Hæmorrhage. — The mechanism by which this complication was brought about varied with the original injury. In the case of an intrasplenic hæmatoma the tensely stretched capsule, weakened by the force of the original blow and softened by the inflammatory reaction following the trauma, finally gave way at its most vulnerable point. The free escape of blood into the splenic pouch and general peritoneal cavity was thus permitted. If temporary hæmostasis had been effected in a frank splenic rupture, a little effort on the part of the patient was sufficient to start the bleeding again. In either case, bleeding, once restarted, was profuse and uncontrollable. In seven cases it was so overwhelming that death occurred within a few minutes; the peritoneal cavity was literally flooded with blood. In most cases, however, rapid and tremendous expansion of the splenic pouch took place, the hæmatoma eventually occupying the entire left side of the abdomen and extending down into the pelvis. Not infrequently this enormous collection

of blood remained localized to the end, none escaping into the general peritoneal cavity. In none except Lejars' case was a true cystic condition found. Well-marked localization was particularly the case if secondary hæmorrhage had taken place in an already existent perisplenic hæmatoma. Even here blood began to spill over as a terminal event. More often the severity of the hæmorrhage caused general peritoneal involvement coincidently with the filling of the splenic pouch, and at operation or necropsy massive clots surrounded the spleen and were distributed throughout the intestinal coils and abdominal fossæ. Patel and Vergnory felt that most of the severe abdominal symptoms arose from the moment general peritoneal extravasation began rather than from bleeding into the splenic pouch. The topographical features of the perisplenic hæmatoma have been considered.

An interesting point with regard to the spleen itself remains to be dealt with. In the case I reported the spleen was found at operation to be in five distinct fragments lying free in the hæmatoma (*see Fig.* 99). Burger found the spleen in three separate pieces. In the cases of McCaw, Pétridis, Wohlgemuth, Patel and Vergnory, and Nast-Kolb, the spleen was practically divided into halves. Most of the other reports recorded the fact that the ruptures found at operation or necropsy were obviously much larger and more extensive than those which could have been inflicted at the original injury. It seems clear that secondary hæmorrhage occurred with considerable violence and that it had a marked shattering and disintegrative effect on the spleen, sufficient even to bring about complete separation of the organ from its pedicle. Whether this occurred immediately after the onset of secondary bleeding, or whether it was a more gradual process, is difficult to determine. The finding of such an extensive lesion at operation without an adequate cause should not blind one to the fact that it had its genesis in a much smaller injury and at a date previous to that of its most obvious clinical manifestations. One should not make the mistake of believing this to be a spontaneous splenic rupture, but rather the end-result of a forgotten or disregarded injury.

TREATMENT.

The operation of choice for rupture of the spleen is splenectomy. Any form of repair or tamponment is inadmissable. Of the thirty-seven cases in which operation was performed, splenectomy was done in every instance, with the exception of Lejars' case, in which drainage of the encysted hæmatoma was carried out. Apart from the almost certain fatal outcome without surgical intervention, the poor results of medical treatment are illustrated by the case reported by von Kolb. Here, despite repeated urging, the patient absolutely refused operation. Convalescence, remarkably achieved, was slow and stormy, and after seven months, with only partial absorption of the hæmatoma, the patient was unable to work, and even walking about required several hours of rest every day.

Since thorough exposure is necessary, splenectomy is best performed through the wide transverse left subcostal incision described by Ruggi and practised by Pauchet and C. H. Mayo. The left upper rectus approach, described by Bevan (Bevan's incision) and Balfour, is also satisfactory.

Transfusion, gum acacia, and oxygen post-operatively are of the greatest benefit and may even be life-saving. Whether one should perform splenectomy before secondary rupture has occurred and during the latent period is a matter for careful consideration. Perrin, who had the happy experience of successfully anticipating a secondary rupture, was strongly of the opinion that it should be done if possible. From a study of the risks involved I am inclined to agree with him. Special emphasis, however, should be laid on the significant point that a patient who has sustained an injury of the left side, particularly with fracture of the ribs, and if there is a suspicion of rupture of the spleen, should be kept at rest and under close observation for at least fourteen days. Sudden and apparently spontaneous internal hæmorrhage could then be attended to with dispatch and with a more certain knowledge of its origin.

MORTALITY.

Operation was performed in 37 of the 46 cases, with a mortality of 27 per cent. Of the 9 patients not operated on, 8 died and 1 recovered. Eight patients died on the table or within forty-eight hours of operation from hæmorrhage and shock; 1 died on the seventh day from peritonitis and 1 from bronchopneumonia on the third day. These figures compare well with those recorded for traumatic rupture of the spleen in general. Thus Bessel Hagen, in 1900, reported 37 cases with 20 recoveries and 17 deaths; Lotsch, in 1908, reported 138 cases with a mortality of 37·7 per cent; and Planson, in 1909, reported 140 cases with a mortality of 37·1 per cent. Buxton, in 1922, found the mortality for all cases up to that time to be 28·8 per cent. In 220 cases in which operation was not performed, Berger noted a mortality of 92·3 per cent. Watkins found the mortality to be 100 per cent. The chance of recovery without operation is clearly exceedingly slight.

Certain factors are involved in the comparatively low operative mortality of 27 per cent. First, few patients had associated injury such as rupture of the stomach or kidney, and, second, many of these patients were under good medical care when secondary hæmorrhage took place. The influence of associated injuries may be judged from the fact that of the 9 patients with fracture of the ribs or rupture of the kidney 7 died as a direct result of the secondary splenic hæmorrhage.

SUMMARY.

1. A case is described in which delayed hæmorrhage from the spleen occurred nine days after the original splenic injury.

2. Forty-five similar cases have been collected from the literature. Clinical study shows that the entire group presents a well-defined clinical syndrome, following the initial hæmorrhage and during the latent period, which should make the diagnosis possible before secondary hæmorrhage takes place.

3. Pathologically, the primary splenic injury consists of three varieties of lesion, the hæmorrhage from which is temporarily or permanently localized by various agencies.

4. The latent period is occupied by attempts at healing on the part of the spleen, and is usually marked by distinctive clinical symptoms.

5. Secondary hæmorrhage takes place in a high proportion of these minor splenic injuries, and is then associated with the same mortality as for splenic rupture in general.

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MALIGNANT GIANT-CELL TUMOUR OF BONE.

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Tumours of bone comprise a group of neoplasms whose many problems, pathological and surgical, are generally appreciated and require no emphasis. Standing out in sharp relief from them owing to even greater difficulties of interpretation, are the giant-cell tumours, particularly the 'benign giant-cell tumour'.

The difficulties surrounding this growth are exemplified by the numerous ideas expressed in the literature as to its origin as well as by the various changes in the general opinion as to its nature during ninety years. Various conceptions of the origin and nature of the benign giant-cell tumour have been expressed in a varied terminology—'myeloid sarcoma',[28] 'giant-cell sarcoma',[2] 'tumeur à myéloplaxes', 'osteoclastoma',[11, 13, 23] 'myeloma',[29] 'myeloid tumour',[7] and 'chronic (non-suppurative) hemorrhagic osteomyelitis'[4] amongst others.

Originally they were regarded as malignant, probably owing to their confusion with the frank bone sarcomata. Their relatively innocent nature was then emphasized by several authorities and for several decades their relative innocence was accepted. Now, however, opinion is veering to an intermediate position, since during the last few years a considerable number of malignant examples have been described. It is the malignant growth which is to be considered here, with special reference to its differentiation from the innocent form.

HISTORICAL.

The giant-cell tumour was described first in 1845 by Lebert. It was further discussed in 1854 by Sir James Paget, who emphasized its benign nature, though stating, "cases may be found . . . in which a malignant course is run". In 1860 Nélaton again expressed the belief that the growths were only locally malignant. This opinion became firmly entrenched in pathological and surgical writings. It may be exemplified by such papers as that of Kramer.[19]

During the last twenty years the controversy as to whether the tumours were really neoplasms or chronic inflammatory conditions has waged. The relationship of certain of these tumours to osteitis fibrosa cystica was also remarked. This dispute is still far from being settled, but a still more important problem has arisen.

In 1923 Stone and Ewing[30] and Turner and Waugh[21] reported examples of 'benign' tumours which showed definitely malignant characters, though

the former considered that their case was an example of a malignant tumour of bone (osteogenic sarcoma) supervening on the innocent growth.

In 1924 Coley[9] reviewed a series of cases and demonstrated that not only are many of such cases malignant, but that the differentiation of the innocent from the malignant may be extremely difficult. He reported further cases in 1927.[10] In 1924 MacGuire and McWhorter[20] reported, in a series of twenty giant-cell growths, four malignant examples. Other cases were reported by Finch and Gleave[13] in 1926 and by Chatterton and Flagstad[8] iu 1927. The case of Finch and Gleave developed pulmonary metastases.

In 1929 Sosman[27] pointed out a radiological peculiarity in malignant examples. In 1931 Dyke[11] and Orr[3] referred to malignancy in what were originally thought to be benign tumours. Last year also Simmons[26] reviewed 116 cases of ' benign giant-cell tumour ' from the Registry of Bone Sarcoma of the American College of Surgeons.

The important feature of all these reports is the apparent impracticability of separating innocent from malignant growths except by means of their clinical course. Since the understanding of abstruse and border-line cases may best be achieved by the appreciation first of the characters of typical cases, this example is given.

CASE REPORT.

J. O., male, age 56. Sought treatment (in 1928) for a 'lump' in his right arm of four years' duration. Except that he had generalized psoriasis, he had had no disabilities. He had had a fall on to his left arm five years before coming for advice, and some time after this he noticed a swelling on the outer side of the lower part of the forearm. This remained stationary in size until two months before he sought attention, when it began to be painful and to enlarge.

On Examination.—There was a swelling about 2 in. in diameter occupying the region of the lower end of the radius. It was hard, not tender, and there was no egg-shell crackling.

X-ray Examination.—The appearance was typical of 'benign giant-cell tumour' of bone. There was concentric enlargement of the bone, thinning of the cortex, though without loss of continuity, and the characteristic trabeculation of the substance of the tumour. The patient was treated by deep X-ray therapy. The increase in size continued and the pain was not relieved.

Five months after first coming for treatment he was admitted to hospital for operation. At this time X rays showed that the condition was similar to that seen previously, but there was loss of continuity of the cortex in several places and there was obvious invasion of the soft tissues by the tumour (*Fig.* 106). The significance of this finding, at that time, was not appreciated.

Operation.—This consisted of removal of the lower quarter of the radius with the introduction of a bone-graft.

Pathological Examination.—Microscopically the tissue consisted of a large number of foreign-body giant-cells of the typical 'myeloid' type (*Fig.* 107), a cellular stroma containing a large proportion of spindle cells, and considerable hæmorrhage. A diagnosis of benign giant-cell tumour was made.

Later, when subsequent events were an incentive to a review of the case, the examination of the remainder of the specimen revealed a very different picture. Many areas were extremely cellular, consisting largely of active spindle cells (*Figs.* 108, 109). Mitotic figures were present in numbers. In some parts a large number of giant cells of both tumour and foreign-body type were present. In some cases the tumour giant cells were in excess (*Fig.* 110). The tissue was very vascular. Destruction of bone was occurring at the growing edge.

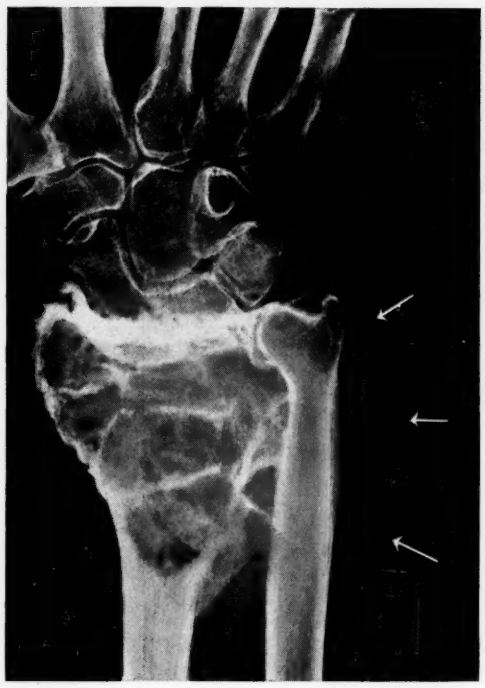

FIG. 106.—Tumour of the left radius. The arrows indicate the site of breaking through the capsule and the extent of the tumour invading the soft tissues. The thickening of the bone and trabeculæ is probably the result of the radiation therapy. Previous films did not show these features, but were typically those of benign giant-cell tumour.

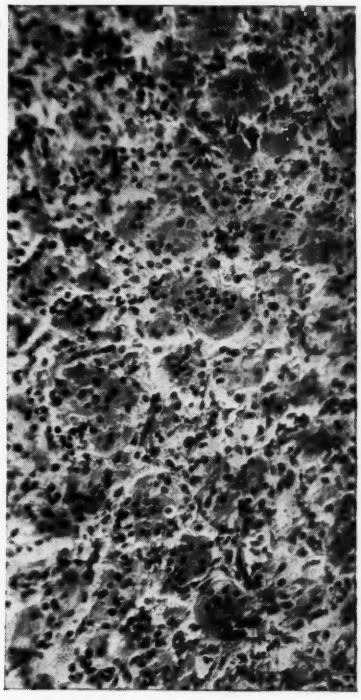

FIG. 107.—Section of the growth which was first examined and on which the diagnosis of benign giant-cell tumour was made. (× 80.)

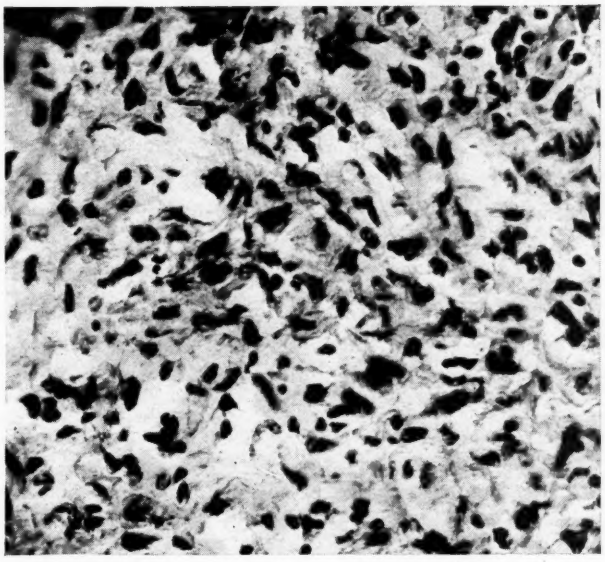

FIG. 108.—Portion of the section showing spindle cells and giant cells. (× 400.)

FURTHER OPERATIONS.—The patient progressed satisfactorily for a time. Six months later fracture occurred through the graft, and since the growth had recurred, amputation through the forearm was performed. Twelve months after amputation a nodule was found to have developed in front of the elbow (? enlarged epitrochlear gland), and this swelling rapidly increased until a large mass was present (*Fig.* 111).

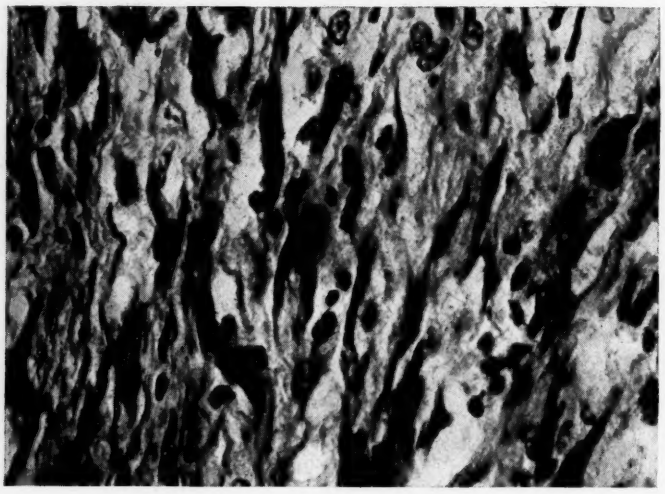

FIG. 109.—Another portion of the tissue showing active spindle cells, some of which are giant cells. (× 400.)

Amputation was performed through the neck of the humerus. No immediate complications resulted.

PATHOLOGICAL EXAMINATION.—The mass caused a fusiform swelling of the arm just above and involving the elbow (*Fig.* 112). It measured 5 in. in diameter and about 8 in. long. The tissue was soft and hæmorrhagic. At its edge it was invading the surrounding tissue.

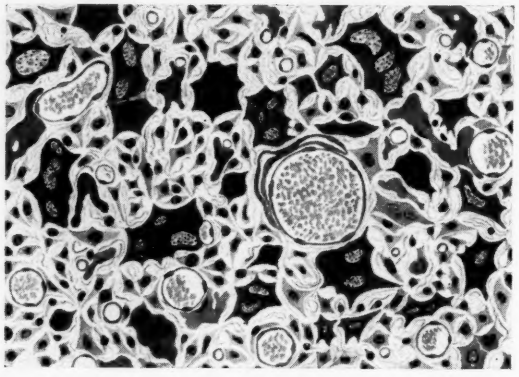

FIG. 110.—Section of another portion of the tumour. There are numerous giant cells, mitotic figures, and a few foreign-body giant cells (hæmatoxylin and Van Gieson).

Microscopically the tissue was very cellular, consisting of spindle, spheroidal, and many tumour giant cells (*Figs.* 113, 114). The tissue was extremely vascular. In some areas many cells were of the bone-marrow type.

Shortly after the second amputation the patient complained of anorexia, cough, disinclination for exertion, and loss of weight.

X-ray examination of the chest showed an appearance consistent with numerous secondary growths in both lungs (*Fig.* 115). There was also an area in the 1st lumbar vertebra suggesting a metastasis. Two months later the patient died suddenly. Unfortunately a post-mortem examination was not obtained.

This case is, in review, a typical example of a malignant giant-cell tumour* of bone and one which is readily distinguishable from the innocent form. It differs from the benign giant-cell tumour: (1) In presenting a peculiar radiological appearance; (2) In its microscopical characters—tumour giant cells, mitotic figures, and a predominance of spindle cells; and (3) In its clinical

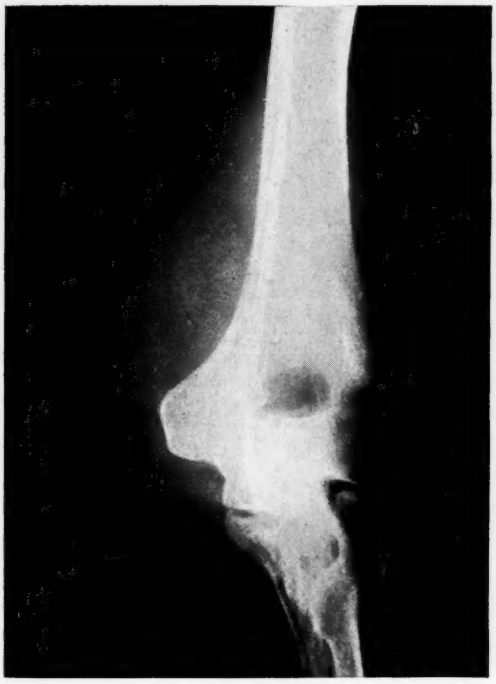

FIG. 111.—The elbow region after the development of the secondary tumour in this region. The secondary growth which was thought on clinical grounds to be in the epitrochlear gland is here seen to be extra-osseous.

FIG. 112.—Photograph of the tumour in the region of the elbow after amputation through the shoulder. H, Humerus; E, Elbow-joint. The section does not pass through the humerus all the way.

course with metastasis formation. Two at least of these features however, (1) and (3), are late developments, and diagnosis before these occur, especially (3), is desirable. Simmons says, "In analysing these cases it is seen that there is no instance in which a proved giant-cell tumour may change its character and become osteogenic." Even if this is true—and accumulated evidence in the literature does not support the statement—it does not help

* The term 'giant-cell tumour of bone' is used in this paper to refer only to the malignant form of the benign giant-cell tumour, and does not refer to obvious osteogenic sarcomata which contain giant cells.

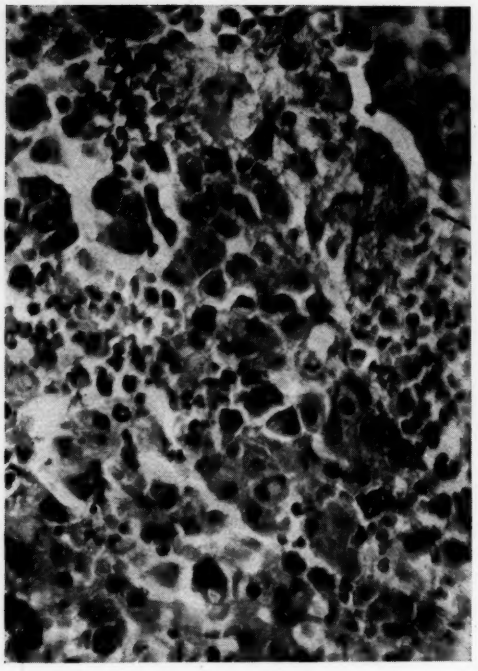

FIG. 113.—Section of the secondary growth in the arm showing the anaplastic and variable nature of the cells. The tissue is extremely vascular. (× 350).

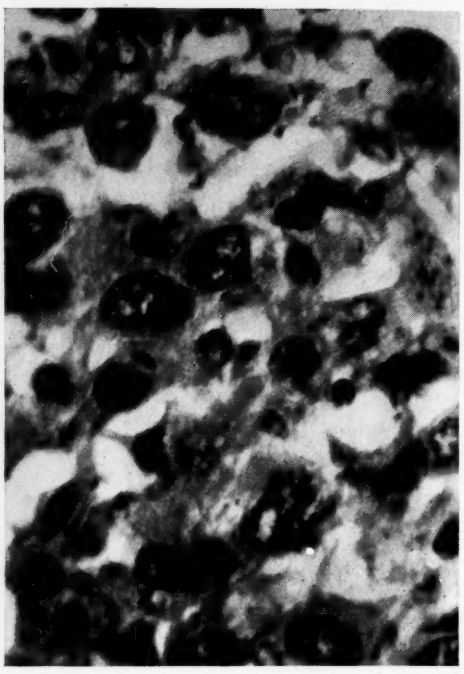

FIG. 114.—High-power photomicrograph of tissue similar to that shown in *Fig.* 113. The cells, which vary in size, contain large nuclei with dense chromatin. They form some tumour giant cells. (× 900.)

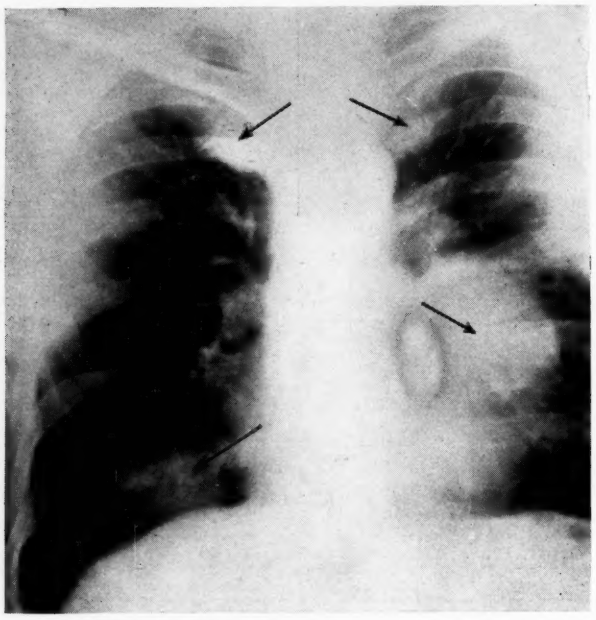

FIG. 115.—Radiograph of the chest obtained shortly after the amputation through the shoulder. The shadows thrown by the metastatic tumour masses are shown by arrows.

when, in the early stages of development of a growth, one is confronted with an X-ray picture typical of benign giant-cell tumour and a typical or almost typical microscopic picture.

A diagnosis of benign giant-cell tumour was made in the early stages in the case here described, but this was due to remediable errors—only one part of the growth was examined microscopically and even some of the features of this portion were overlooked, and the radiographs were incompletely interpreted. When the case was reviewed it was noticed that the tumour had invaded the surrounding tissues.

In 1919 Bloodgood[6] submitted evidence from which he considered it could be concluded that destruction of the bony capsule of the growth was no evidence of malignancy. His cases, however, do not allow of this conclusion, since in several amputation or radical removal of the growth was performed. That cure results from this treatment only means that these growths are not of the same order of malignancy as the osteogenic sarcomata. Though this invasion of the soft parts by the tumour described in this paper was an original observation at the time at which it was made, search of the literature subsequently showed that Sosman had also referred to it. It is well shown also in the illustrations of many of the cases described in the literature (e.g., see Bloodgood's[6] and Coley's[9] papers).

Most of the statements made concerning these tumours conclude with the opinion that differentiation between the innocent and malignant varieties is not possible. Simmons[26] concluded this from the study of the 116 cases in the Registry of Bone Sarcoma. Coley[9] obtained opinions from a number of well-known pathologists and received diametrically opposed opinions from some of them on the same or similar material. The inference that differentiation is therefore impossible is, however, quite unreasonable. All that we can deduce is that, in the present state of our knowledge, diagnosis is extremely difficult. In the final analysis, malignancy or innocence may be determined only by the life-history of the tumour, and the microscopic appearance must be correlated with this. Prognosis can only be argued (with any degree of certainty) from the microscopic appearances after certain microscopic findings had been observed to be associated with a definite clinical course over a large series of cases. This somewhat obvious even if not axiomatic statement is, I think, not sufficiently appreciated. Our present knowledge of bone sarcomata is not complete enough to allow of the accuracy of diagnosis and prognosis which is possible with—for example—some of the carcinomata and other tumours.

Are there any criteria at all that will aid in the diagnosis of these tumours ? There are three possible sources of information, the clinical observations, pathological investigations, and radiological examination.

1. There do not appear to be any criteria of differentiation of malignant from innocent giant-cell growths by clinical investigation in the early stages. The development of metastases as a mode of differentiation is unsatisfactory, to say the least, from the patient's point of view.

2. So many errors have been made during the last few years in the microscopic diagnosis of the malignant forms of the giant-cell growths that at first sight the opinion expressed by several writers seems almost justified.

However, a few features are worth consideration. In the typical example there is a predominance of spindle-cell tissue, the presence of mitotic figures, tumour giant cells. The typical picture of the benign growth, on the other hand, is a polymorphic tissue containing round and spindle cells, foreign-body giant cells, and hæmorrhagic and degenerative foci.

These two forms may be intermingled, and such cases are those which present the difficulties. It has been pointed out by several writers, and particularly by Ewing, that injury, hæmorrhage or infection, or bone destruction in a tumour of bone may result in the formation of giant cells surrounded by a cellular stroma of pleomorphic cells. The significance of this observation is that the foreign-body giant cells must be ignored in making a diagnosis and an attempt made to disentangle the true stroma of the tumour from the various inflammatory cells which may be intermingled with them.

That irritation (mechanical, chemical, or bacterial) may give rise to a change in type of a benign giant-cell tumour is stated by several authorities. The evidence for this opinion seems to be good, though by no means complete. Malignancy undoubtedly develops in a number of cases which are submitted to trauma. These are the very cases in which the microscopic picture is most confused and most closely approximates to that of the benign giant-cell growth. In some areas it may be identical.

This may be exemplified by one of several examples: I was asked to examine a piece of tissue which had been removed from a tumour in the upper end of the tibia. It was thought, clinically, to be a benign giant-cell tumour. Microscopic examination showed a tissue consisting of spindle cells mainly, with one mitotic figure in about two lower-power fields. There were numerous foreign-body giant cells and no tumour giant cells. The report of a malignant tumour was made. Other opinions of an opposite nature were obtained by the surgeon in charge of the case, and he was satisfied with curettage. Three months later the tumour recurred and fungated through the wound. A fresh piece of tissue on microscopic examination presented an even greater resemblance to the benign giant-cell tumour, the foreign-body giant cells being even more abundant and the stroma even more pleomorphic. This was then used as evidence for the conclusion that it was not possible, microscopically, to differentiate malignant from innocent growths, although areas in which spindle-cell tissue predominated and where mitotic figures were present were found. Such a conclusion, however, ignores the relationship of the excess foreign-body giant cells and inflammatory cells in the stroma with hæmorrhage or infection of the growth. The patient died later from pulmonary metastases.

I would state, therefore, that with careful examination of the tissue and the correct stress on the various parts of the tissue it should be possible in many cases at least to determine that the growth is malignant. I have found the most valuable criterion to be the presence of an occasional mitotic figure. The search may resemble that for tubercle bacilli in a section stained specially for them. When one is found, however, others are usually also quickly discovered. Later others or more satisfactory criteria may also be found, and a search for them is necessary before drawing the conclusion that they are completely absent.

That different parts of a tumour may show very different morphological appearances requires special attention. If hæmorrhage or infection involves one portion of a growth more than another, then in all probability—as suggested above—such areas will more closely resemble the benign form of growth. This should be remembered also when pieces of tissue are obtained for microscopic examination.

3. Radiological investigation in the early stages may throw no light on the prognosis of the growth. Before long, however, some variations in appearance may be found, particularly loss of continuity of the covering bone and invasion by tumour mass of the surrounding soft tissues (*see Fig.* 106). The trabeculation may become less regular than is usual. It is necessary therefore to repeat the radiological examination of the growth at intervals and watch particularly for such changes.

During the last few years I have encountered six cases in which this question of type and malignancy of the growth has arisen and which proved to be malignant. An erroneous conclusion was drawn in two of these, but in retrospect this was due to non-observance of the conclusions drawn here—for example, in one case only one small piece of tissue led to a diagnosis which, even now, on that particular slide seems justified. This was taken from a fungating piece of growth which was infected. In another case the (then) doubtful microscopic picture was considered to be subservient to the clinical history and the radiological appearances.

In view of the observation of Simmons that 7·5 per cent of the ' benign giant tumours ' treated conservatively give rise to pulmonary metastases, it is necessary to examine the tumours as carefully and fully as possible, make repeated radiological examinations, and accept any one criterion of malignancy even if not supported by other findings and even if this is found only in one part of the growth.

On the first evidence of malignancy the growth should be removed. It has been shown that complete removal of these tumours in an early stage of development or, according to some authorities, before the growth has changed to an osteogenic sarcoma, will prevent the formation of metastases.

SUMMARY.

An example of a malignant form of giant-cell tumour of bone is described. The means by which the malignant growth may be distinguished from the innocent form are discussed.

Microscopically the stroma is cellular, composed mainly of spindle cells with active nuclei and an occasional mitotic figure. Tumour giant cells, when present, are very characteristic. Foreign-body giant cells and pleomorphic stroma, so characteristic of the innocent ' growth ', must be disregarded when determining prognosis, since they may predominate if degeneration, infection, or bone destruction is present in the area under examination. In order to minimize this difficulty specimens should be taken where possible from areas which do not show these complications.

In the later stages of development of the growth there is a characteristic radiological appearance. Thus it is necessary in a doubtful case to make

radiographic examinations at intervals in order to observe the earliest sign of invasion of the bone cortex or the surrounding tissues. Several portions of the growth should if possible (e.g., when curettage is performed) be examined. Positive evidence of any kind, even if found in only one part, should be accepted to the exclusion of negative evidence.

I would thank Mr. A. F. Maclure, F.R.C.S., for the notes of the case, and Dr. L. A. Love for assistance in the elucidation of the radiographs.

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THE RELATIONSHIP BETWEEN PEPTIC ULCERATION AND GASTRIC CARCINOMA.*

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HISTORICAL INTRODUCTION.

The history of this problem commenced with Cruveilhier, who in 1839, in his *Atlas of Pathological Anatomy*, was the first to distinguish clearly between chronic ulcer and carcinoma both clinically and pathologically. He also discussed the association of the two conditions and finally says: "La question de savoir si un ulcère chronique simple peut devenir cancéreux ne me parait devoir être résolue d'une manière affirmative que pour les individus affectés de la diathèse cancéreuse."

A few years later (1842) Rokitansky stated that cancer sometimes occurred with simple ulcer and that it might arise from the ulcer. Dittrich, in 1848, collected 160 cases of cancer of the stomach and found 6 developing near ulcers; in 2 of these the carcinoma was limited to the edge of the ulcer. He appears to have regarded this as a coincidence rather than a causal factor. Brinton, in 1858, published a full description of "a case of cancerous infiltration of a chronic gastric ulcer." It was in the middle third of the lesser curvature and eroded the liver. Its floor and edges were cancerous. He had little doubt that it was a gastric ulcer which had undergone a cancerous infiltration or deposit because of: (1) Long duration; (2) Absence of cachexia as well as secondary deposit; (3) Healthiness of the gastric tissues around; (4) Exact coincidence of deposit and ulcer. Later (1864) he discusses the question more fully and seems to think the combination of ulcer and cancer not a mere coincidence. He also mentions the question of peptic ulceration of growths and considers the complete destruction of a tumour by peptic digestion to be possible in rare instances.

In 1868 two theses on this subject were presented to Berlin University by Steiner and by Wollmann. Both estimated the proportion of cases of carcinoma arising in ulcer at 4 per cent, but neither produced any morbid anatomical proof of their statements. Mayer (1874) published a case of carcinoma of the stomach which macroscopically resembled a callous ulcer, but on histological examination showed islets of carcinoma in it. This appears to be the first recorded histological examination of an ulcer-cancer. These three papers were well received in Germany and were the means of popularizing the idea that gastric ulcer was at any rate sometimes followed by carcinoma.

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* A thesis for which the Raymond Horton Smith Prize of the University of Cambridge was awarded in 1931.

They seemed to have caused Lebert to alter his views, for in 1861 he said that cancerous degeneration in simple ulcers is possible but has not yet been demonstrated, while in 1878 he estimates that 9 per cent of gastric cancers are produced in this way.

Four years later Hauser (1882) described a case of ulcer-cancer which had been found accidentally at autopsy on a man dying of pneumonia with no history of previous indigestion. He also emphasized its importance in the etiology of gastric cancer in general. Discussing this paper, Zenker expressed the opinion that most cases of carcinoma of the stomach arise in pre-existing peptic ulcer.* Hauser published several papers, and in 1890 a book on carcinoma of the stomach and intestine in which four cases of ulcer-cancer were described and one was illustrated. This illustration has been copied many times—notably in Ewing's text-book—and remains the classical example of ulcer-cancer.

Duplant, in 1898, attacked these views in his thesis at Lyons. After outlining the previous work on the subject, he describes fully eight cases of supposed ulcer-cancer and concludes that they were " en réalité de néoplasmes ulcérés." He suggested that one type of carcinoma is similar to the rodent ulcer of the face, and when ulcerated closely resembles simple peptic ulcer. He quotes Tripier and Bard as having seen cases where the primary carcinoma has ulcerated away and the essential malignant nature of the ulcer could only be diagnosed by the presence of metastases. Finally he says that his observations make him believe that the grafting of carcinoma on ulcer is impossible.

Similar views that ulceration of primary carcinoma is more common than cancerization of an ulcer, have been put forward by Stromeyer (1912) and others from Aschoff's school, Moskowicz (1924), and many others.

The chief exponents of the opposite view, that most cases of carcinoma arise in pre-existing peptic ulcer, have been the surgeons and pathologists of the Mayo Clinic. Starting with W. J. Mayo in 1907, a long series of papers has been published by McCarty, Broders, Wilson, and others, all expressing the view that 50 to 70 per cent of gastric cancers arise in ulcers.

Very many papers have been written on this subject, and the way in which opinions have varied is shown in *Figs.* 116, 117. *Fig.* 116, copied from Cabot and Adie (1925), shows the way the pendulum of opinion has swung

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* This opinion of Zenker's seems to have been exaggerated by many later writers. For instance, Duplant (1898) says : " Zenker, dans un enthousiasme qui n'a rien de germanique, n'hésite pas à déclarer que tous les néoplasmes de l'estomac ont l'ulcus comme point de départ ", and gives the reference (*Berl. klin. Woch.*, 1882). Audistère (1903) also quotes the same reference and says that for Zenker " tous les cancers de l'estomac se développent sur les ulcères simples." Cabot and Adie (1925) make the statement that Zenker " proposed the idea that all gastric carcinoma originated in ulcer ", and Stewart (1929) remarks, " The swing of the pendulum reached its height with Zenker (1882), who expressed the opinion that most if not all cancers have their origin in simple ulcer." Several other writers make similar statements, and the only reference given to support them is that from *Berl. klin. Woch.*, 1882, xix, 657. This turns out to be the report of a meeting of a congress at Eisenach, where Zenker congratulated his assistant Hauser on his paper " und spricht die Meinung aus, dass auch aus dem klinischen Verlaufe vieler, ja der meisten Fälle von Magencarcinom auf ein vorhergegangenes Magengeschwür zu schliessen sei." Unfortunately it has not been possible to obtain a verbatim report of Zenker's remarks or to find any other reference. It is difficult to understand how 'meisten Fälle' has been translated as 'all' or '100 per cent.'

between 1845 and 1925. *Fig.* 117 is a graph in which the number of reports expressing similar percentage figures of the frequency of ulcer-cancer is plotted against the percentage figure given. A similar graph is given by Cabot and Adie, but as it is not drawn to scale and no references as to the source of the figures are given, it has been neglected. The source of the figures in *Fig.* 117 is given on p. 305. The total number of reports collected is 102, and it will be noticed that 51, or one-half, estimate that not more than 10 per cent of gastric carcinoma arise in ulcers; 74 believe it is less than 20, and only 15 give an estimate over 50 per cent.

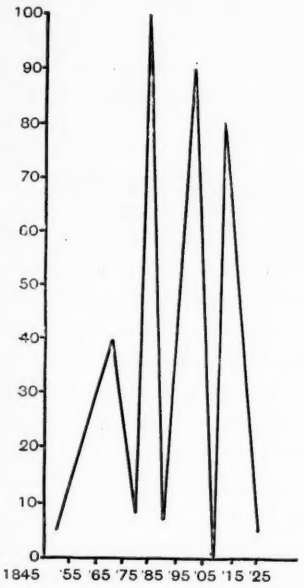


FIG. 116.—Variation of opinion between 1845 and 1925 of number of gastric cancers arising in ulcers. (*From Cabot and Adie.*)

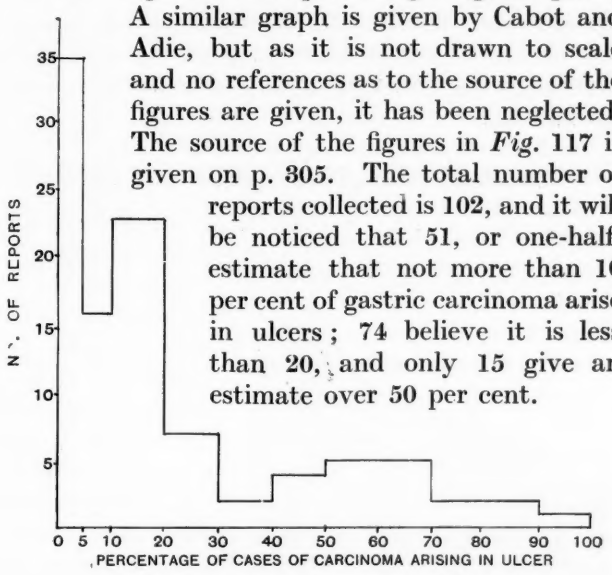


FIG. 117.—Graph showing number of reports expressing similar percentage figures of the frequency of ulcer-cancer in gastric carcinoma.

MATERIAL.

The material studied for the purpose of this paper consists of all the portions of stomach from surgical operations received in the Department of Pathology, St. Mary's Hospital, Paddington, from January, 1920, to April, 1931, inclusive. Most of them have come from cases in hospital, but a few have been sent from outside. In all, 307 stomachs were received, and their various lesions are shown in *Table I.*

Table I.—VARIOUS LESIONS IN 307 STOMACHS.

Simple chronic gastric ulcer	154
Gastric carcinoma	46
Duodenal ulcer	75
Jejunal ulcer	7
Subacute gastric ulcer	4
Other cases omitted	22
Total	307*

* These figures add up to 308 as in one case (576125) both ulcer and cancer were present although separated (*see* p. 302)

The cases omitted were :—

Too little received for diagnosis	10
Gastrojejunostomy junctions	3
Gastritis	2
Hypertrophied pylorus	2
Myoma	2
Sarcoma	1
Linitis plastica (inflammatory)	1
Carcinoma of œsophagus	1

To form a control group 112 consecutive operation cases of carcinoma of intestine were studied also. Post-mortem material has not been used for statistical purposes, although it has been used in certain cases to amplify observations made with the surgical material. In order to have clear ideas on the relationship between peptic ulcers and gastric carcinoma it will be necessary to consider briefly the morbid anatomy and histology of these conditions.

MORBID ANATOMY AND HISTOLOGY OF PEPTIC ULCERS.

Peptic ulcers, as their name implies, are the result of digestion of the stomach or intestinal wall by gastric juice. The factor or factors necessary to allow this digestion to take place, be they inflammatory, nervous, ischæmic, or otherwise, do not concern us now. We are only interested in their morbid anatomy and histology. They are usually divided into two groups—acute and chronic. It is only the latter which need be considered here; but it is now generally recognized, following the work of Bolton and others, that the so-called chronic ulcer arises from an acute ulcer in which healing is delayed—in fact, peptic ulcers are not chronic in the sense that tuberculous and syphilitic lesions are chronic, but rather represent the balance at any one time between successive attacks of acute digestion alternating with periods of healing. The digestive action, whenever it takes place, is an acute process; between the active attacks repair is taking place. The appearance of an ulcer, therefore, will vary greatly according to the phase of the attack in which it is removed and also the number of attacks which have occurred.

FIG. 118.—Multiple peptic ulcers in stomach. Pyloric end of stomach and beginning of duodenum showing two chronic gastric ulcers in pyloric canal. The larger is on the lesser curvature and the smaller on the posterior wall. (× ⅔.)

Number. — Acute ulcers are frequently multiple, chronic are usually single. *Table II* shows the multiple ulcers in this series. (*Fig.* 118.)

Table II.—MULTIPLE PEPTIC ULCERS.

	Cases
Two chronic gastric ulcers	7
Two chronic gastric ulcers and chronic duodenal ..	1
Chronic gastric and chronic duodenal	3
Chronic gastric and acute duodenal	1
Total	12 in 154 (7·8 per cent)

Of the duodenal ulcers, 18 out of 75 (24 per cent) were multiple.

Position.— The position of chronic gastric ulcers is to a large extent restricted to the neighbourhood of the lesser curvature (*see Fig.* 121) and the

pyloric canal, the so-called 'Magenstrasse' or gastric pathway. The position of the cases in this series is shown in *Table III*, Professor Stewart's figures being added for comparison.

Table III.—Showing Position of Ulcers.

Position	Number	Percentage	Prof. Stewart's Percentage	
			Surgical	P.M.
Lesser curvature	135	83·8	96·5	82
Pyloric canal	11	6·8	3·5	12
Pylorus	14	8·6		
Cardia	—	—	—	1
Anterior wall	—	—	—	2
Posterior wall	1	0·6	—	3

'Lesser curvature' includes all ulcers touching or within 2 cm. of the lesser curvature. Under 'pylorus' are included those actually involving the pyloric sphincter. Except in the case of one ulcer which had duodenal mucosa on one side and gastric on the other, all these ulcers were definitely on the gastric side of the pylorus, having gastric mucosa on both sides. These observations are in agreement with Moynihan (1923) that an ulcer is either duodenal or gastric, but do not agree with his further statement that a gastric ulcer is rarely within an inch and a half of the pylorus.

Shape.—The shape of the ulcers varies greatly. The smaller ones are generally more or less circular, the larger oval with the long axis in the long

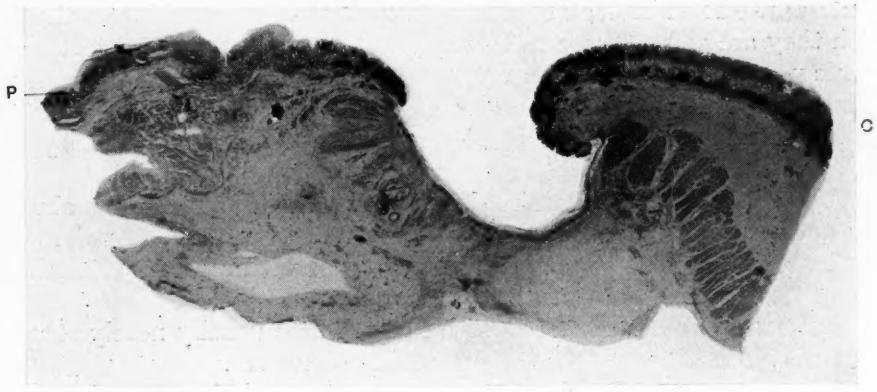


Fig. 119.—Active chronic gastric ulcer. This is in an active phase and shows the 'layers' in base. The shape with overhanging cardiac edge and shelving pyloric edge is characteristic. P and C point to the pyloric and cardiac end respectively. (× 3·6.)

axis of the stomach or else saddle-shaped riding over the lesser curvature. They are irregular, usually more or less terraced or shelving in their edges, and a very frequent appearance is for the edge on the pyloric side to slope gently downwards while that on the cardiac side is steep or overhanging (*Figs.* 119, 120).

Size.—The ulcers vary greatly in size. The largest in this series was 3 cm. diameter, the majority being about 0·5 cm. It has been stated that ulcers above a certain size, generally given as 1 in. in diameter, are malignant.

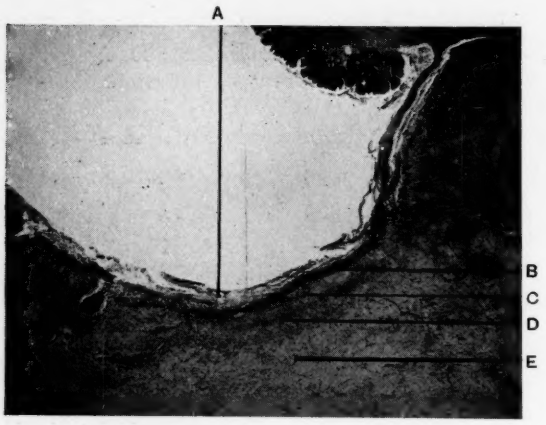


FIG. 120.—Cardiac side of the ulcer in *Fig.* 119 under higher magnification to show 'layers'. A, Mucus with a few leucocytes; B, Fibrin and leucocytes; C, Necrotic layer; D, Granulation tissue; E, Fibrous zone. (× 10.)

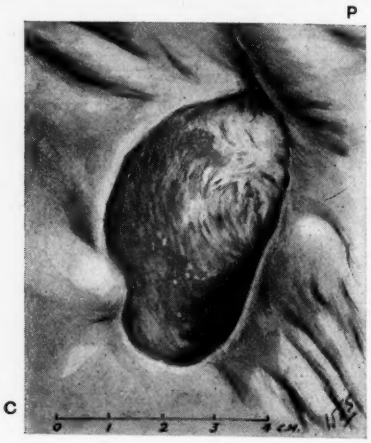


FIG. 121.—A large peptic ulcer with an eroded vessel in its base. It is on the lesser curvature, P and C pointing to pylorus and cardiac end respectively. (× ⅔.)

This is, of course, quite untrue. Size has nothing to do with malignancy. A large ulcer removed post mortem is shown in *Fig.* 121. The largest I have seen in another post-mortem specimen was 9·5 cm. × 5·5 cm., but many larger have been recorded.

Histology.—The histology of ulcers naturally varies according to the phase in which they are seen. Since Askanazy (1920) published his classical account of chronic peptic ulcer, it has been customary to describe the floor of the ulcer as having several zones or layers in the active phase of ulceration (*Fig.* 120).

1. The surface is often covered by mucus in which a few leucocytes are entangled.

2. A fibrinous layer containing leucocytes. This layer is most abundant in very active ulcers, when it usually contains many neutrophil polymorphonuclear leucocytes. In very early ulcers, or those with a recent exacerbation, the leucocytes may be scanty.

3. A necrotic layer permeated with fibrin. It is usually nearly structureless, but may contain the 'ghosts' of arteries or nerves.

4. A zone of granulation tissue generally sharply separated from the necrotic layer above but gradually blending into the fibrous zone beneath. It is made up of fibroblasts which are forming collagen fibre and capillary loops which are not often very numerous. This zone is always infiltrated by leucocytes: eosinophils, plasma cells, and lymphocytes being the most numerous. Neutrophil polymorphs are usually absent.

5. A dense fibrous zone. This is not sharply demarcated from the zone above it and spreads beyond the margins of the ulcer at its edges. In some cases it is remarkably vascular and in others vessels may be scarce. It sends

processes into and often contains nodules of the fatty tissue of the lesser omentum.

Margins.—The margins of the active chronic ulcer vary considerably. Where active digestion is taking place they are usually sharply defined, but may overhang, especially on the cardiac side of the ulcer. In this way the mucosa and muscularis mucosæ may be bent down towards the base of the ulcer. When healing is taking place the edges become more shelving; this is usually seen especially on the pyloric side.

Muscular Coat.—This is usually destroyed in chronic ulcers, and was in all but five of those in this series. In the active phase the muscular fibres may stop abruptly at the edges of the ulcer, but more usually they are separated by œdema, granulation tissue or fibrosis spreading between the fibres. In this way the muscular tissue is generally spread out fanwise at the edge of the ulcer. As the process of healing progresses the overhanging muscularis mucosæ and the spread-out fibres of the muscularis become approximated and eventually fuse. This close approximation or fusion of the muscularis and muscularis mucosæ was present in some part of all but two ulcers in this series. (*Figs.* 122, 123.)

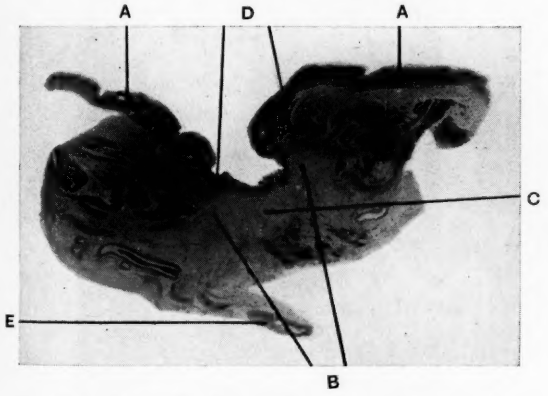


FIG. 122.—Healing peptic ulcer of stomach. A, Muscularis mucosæ; B, Area in which muscularis is destroyed; C, Area of dense fibrosis; D, Points of fusion between muscularis mucosæ and muscularis: E, Vessel with endarteritis. (× 3.)

FIG. 123.—The cardiac side of the ulcer in *Fig.* 122 with higher magnification to show the muscularis mucosæ curling round and fusing with muscularis. A, Muscularis mucosæ; D, Point of fusion between muscularis mucosæ and muscularis. (× 10.)

Hauser (1895) called attention to the way in which the muscular coat is frequently turned up into the floor of the ulcer owing to the contraction of the cicatricial tissue formed in the subserous region and in the omentum. This is frequently present, but by no means peculiar to peptic ulcers; in fact, the contraction of similar subserous fibrous tissue in carcinomata of the large intestine is often the cause of the tight annular constriction seen in these cases.

Blood-vessels.—The blood-vessels in and near an ulcer are frequently the site of pathological changes. Obliterative endarteritis, phlebitis and thrombosis, sometimes with recanalization, are the changes most frequently seen.

Healing (*Figs.* 124–126).—This commences with the separation of the slough formed of the necrotic tissue and fibrin. The granulation tissue layer becomes organized and the newly formed fibrous tissue contracts. At the same time the epithelium at the edges grows in over the surface of the granulation tissue as a single layer of cubical or flattened cells. These go on proliferating and send small downgrowths into the granulation tissue, which at the same time pushes up little papillary processes. These processes become vascularized and the cells covering them often become tall and columnar. In this way a new mucosa is formed. It never returns to the normal, but is always thinner. The glands are fewer and are lined by a lower type of epithelium.

FIG. 124.—Chronic gastric ulcer healing in some parts and extending in others. (× 3.)

This regeneration of mucosa implies active growth of epithelial cells. If at the same time the newly formed fibrous tissue on which the epithelium is resting contracts, it will draw down actively growing epithelium into the deeper tissues. In this way regenerating epithelium at the edge of ulcers is frequently misplaced and may be seen situated deeply in the submucosa or even in the muscularis. This is a frequent occurrence in healing ulcers and was present in 44 of 161 ulcers (29 per cent) in this series.

FIG. 125.—The left side of the ulcer in *Fig.* 124 with higher magnification. At the edge of the main ulcer the epithelium is growing in and forming large papillæ. Quite near to the healing area is a small secondary crater where digestion has recently been active. Further away from the ulcer in the fibrous zone there is an area of deep epithelial heterotopia (A). (× 12.)

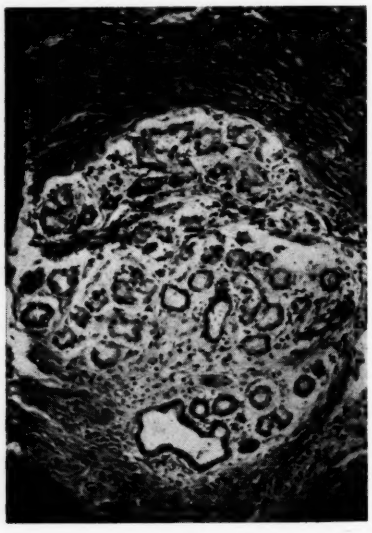


FIG. 126.—The area of heterotopic epithelium seen in *Fig.* 125 under higher magnification to show the regular cells of low cubical shape. This is not carcinoma. (× 120.)

MORBID ANATOMY AND HISTOLOGY OF GASTRIC CARCINOMA.

Number.—Carcinomatous lesions are nearly always solitary, and in this series there is no example of multiple carcinomata.

Position.—The position of the lesions is shown in *Table IV*, to which again Professor Stewart's figures have been added for comparison.

Table IV.—Position of Lesion in Gastric Carcinoma.

Position	Number	Percentage	Prof. Stewart's Percentage	
			Surgical	P.M.
Pyloric canal	23	57·5	88·7	66·5
Cardiac end	—	—	—	15·2
Lesser curvature ..	8	20	7·5	12·8
Rest of stomach ..	9	22·5	3·8	5·5

Size and Shape.—Gastric carcinoma may roughly be divided into three groups :—

1. Vegetating or fungating cases (*Fig.* 127) which grow mainly into the lumen of the stomach and form large cauliflower-like masses. Eight examples of this type occurred in this series. The smallest was 3·5 cm. in. diameter,

Fig. 127.—Fungating carcinoma of pyloric end of stomach. (× ⅔.)

and the largest 9·5 cm. Post-mortem specimens up to 30 cm. in diameter at one time were not uncommon.

2. Leather-bottle stomach or linitis plastica (*Fig.* 128), a condition in which the growth rapidly infiltrates a large area of stomach wall. The site of the starting-point of the growth can usually be seen as a small ulcerated area,

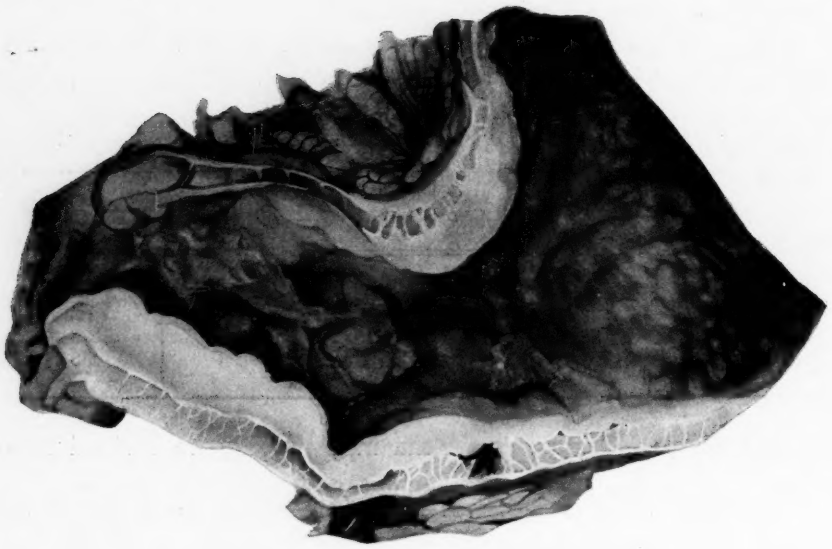


FIG. 128.—Half a leather-bottle stomach removed at operation. ($\times \frac{2}{3}$.)

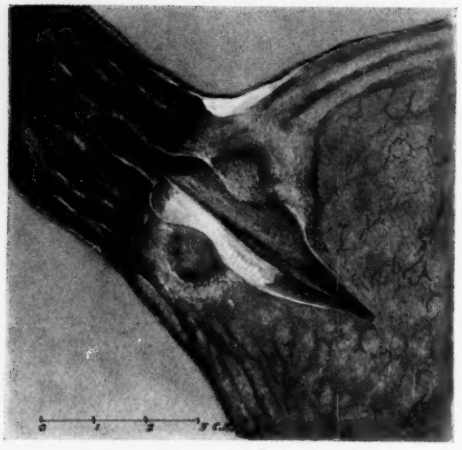


FIG. 129.—Ulcerated carcinoma of stomach. A portion of stomach and duodenum opened along the lesser curvature to show an ulcerated carcinoma on the greater curvature. ($\times \frac{2}{3}$.)

generally at the pyloric end. The growth usually spreads widely in the submucous and muscular coats. Three examples occur in this series, and as in each case the growth extended up to the edge of the portion removed, it is impossible to estimate their sizes.

3. Ulcerated infiltrating cancer (*Figs.* 129, 130). This group is the most important for the purposes of this paper, as these are the cases often thought to arise in peptic ulcers. Thirty-three were present in this series. The ulcerated carcinoma has a crater which may penetrate to any depth or even perforate the stomach wall. Its edges are usually raised and irregular, and the base is hard. In size they vary considerably. The smallest in my series was 1·5 cm. in diameter across the ulcer, while the largest was 4·2 cm.

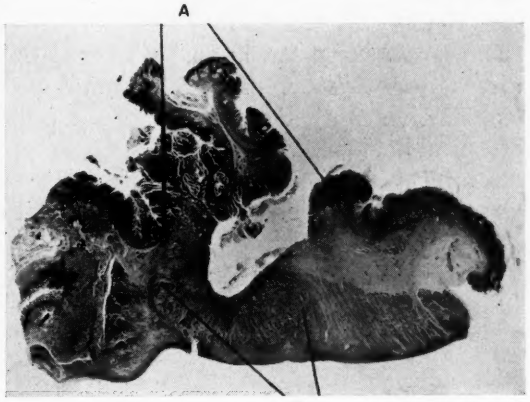


FIG. 130.—An ulcerated carcinoma of stomach. A, Muscularis mucosæ thrown up by carcinoma in submucosa; B, Carcinoma in muscularis between but not destroying the muscle fibres. (×2.)

Examination of a cut surface or section with a hand lens will usually make clear several features. The carcinoma at the base of the ulcer is generally spreading centrifugally in all directions; especially it tends to grow into the loose connective tissue of the submucous coat, and so separate the muscularis mucosæ from the muscularis. Typically the growth can be seen invading the muscularis running between the muscle fibres but not destroying them completely. If the growth has been present for some time, the muscle may be completely destroyed in the centre, but usually a few muscle fibres can be made out. The amount of fibrous tissue formed will vary according to the type of growth—scirrhous or medullary. As a general rule, large areas of fibrous tissue free from growth are not produced.

Histology. — The finer histology of carcinoma does not affect the argument of this paper, and may be briefly dismissed. Most commonly the growth is arranged in alveoli, tubules, or papillæ lined or covered by columnar cells. Sometimes the growth is almost entirely undifferentiated, consisting of solid masses and trabeculæ of polygonal cells. Occasionally, as in the leather-bottle type, the cells are so few and arranged in such small groups that their epithelial nature may be difficult to determine.

HISTOLOGICAL CRITERIA FOR THE DIAGNOSIS OF ULCER-CANCER.

The problem is twofold :—

1. **The Diagnosis of the Pre-existence of Simple Ulcer.** — There are four points in which a simple ulcer usually differs from carcinoma in the stomach: (*a*) Complete destruction of an area of muscle corresponding in size roughly to the floor of the ulcer; (*b*) The presence of a large area of dense

fibrous and granulation tissue in the floor of the lesion; (*c*) The presence of endarteritis obliterans or thrombophlebitis in the vessels around; (*d*) Fusion or close approximation of the muscularis mucosæ and muscularis at the margin of the ulcer. All these points are usually, but not invariably, present in chronic peptic ulcers. *Table V* shows the number of gastric ulcers in which they were present in this series. It also shows their presence or absence in 88 chronic peptic ulcers in the duodenum or jejunum.

Usually in considering these criteria no attempt has been made to apply them to carcinomata in some other part of the alimentary tract where peptic ulcers do not occur. This has been done (Newcomb, 1930) with a series of 112 consecutive cases of carcinoma of the intestine removed surgically at St. Mary's Hospital between 1920 and 1930. Twelve cases had to be omitted as insufficient material was received for a complete examination. *Table V* includes the cases thought to be primary carcinomata and ulcer-cancer respectively.

Table V.—Frequency of Four Criteria in the Histological Diagnosis of Ulcer-Cancer.

Material	Muscle in Base of Ulcer		Fibrosis			Arteritis		Muscularis and Muscularis Mucosæ		
	Present	Absent	Slight	Mod.	Marked	Present	Absent	Separated	Unchanged	Fused
161 gastric ulcers..	5	156	—	—	161	116	45	—	2	159
Percentage of gastric ulcers	3	97	—	—	100	72	28	—	1·2	98·8
88 duodenal and jejunal ulcers ..	13	75	—	—	88	16	72	—	1	87
Percentage of 249 peptic ulcers ..	7	93	—	—	100	53	47	—	1·2	98·8
100 carcinomata of intestine ..	94	6	79	10	11	16	84	94	6	—
40 gastric carcinomata	38	2	22	2	16	6	34	40	—	—
Percentage of gastric carcinoma ..	95	5	55	5	40	15	85	100	—	—
6 ulcer-cancers ..	—	6	—	—	6	6	—	—	—	6

To consider these points in greater detail:—

a. From *Table V* it appears that the muscle is completely destroyed in the base of 97 per cent of all peptic ulcers. Of the five cases in which it remained, all were definite chronic ulcers with much fibrosis around. It is true that one has a history of only nine months, but the others have long histories, two of three years, one of twenty-five, and one of thirty-four. On the other hand, the muscle was completely destroyed in a considerable area of 6 per cent of carcinomata of the intestine where peptic ulceration is out of the question. It would seem then that this point, although a useful aid in diagnosis, is not absolute.

b. As by definition a chronic peptic ulcer is one in which periods of healing have taken place, it is obvious that fibrosis must be present in 100 per cent of cases. In the carcinoma of intestine group marked fibrosis was present in eleven cases. In one of them (*Fig.* 131) an area about 0·5 cm. in diameter

was free from cancer cells. In the others, although the growth was scirrhous in type, cancer cells were scattered in groups throughout the fibrous tissue. If a small area of cancer-free fibrosis can be formed in this way it seems possible that large areas may be also. As Paterson (1914) says, "We know that in cancer of the breast there may be formation of scar tissue, Nature's attempt at arrest of the disease."

It is noticeable in *Table V* that while only 11 per cent of the intestinal carcinomata show marked fibrosis, 40 per cent of the primary carcinomata of the stomach exhibit this point. It seems probable that this higher percentage of cases in the stomach may be due to secondary peptic ulceration of the cancer. It is probably easier for peptic ulceration to extend through a carcinomatous growth than through the normal stomach wall, for nearly all growths are more or less ulcerated. If, then, the normal tissues are reached by the peptic juice, a peptic ulcer may develop within or beneath the growth. The question then arises whether under these circumstances a good healing reaction will take place with the formation of dense fibrous tissue. That this does occur was suggested by Stromeyer (1912). It is fully discussed with the aid of most useful diagrams by Moskowicz (1924), his conclusion being that typical peptic ulcers often occur in or adjacent to carcinomata. A case in this series in which it is probable that this ulceration has occurred is described later.

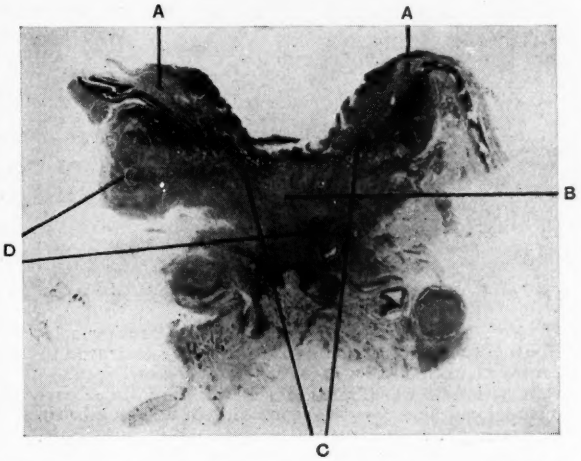


FIG. 131.—Carcinoma of large intestine. A, Carcinoma growing in submucosa and separating muscularis and muscularis mucosæ; B, Area of dense fibrosis in centre of ulcer—groups of cancer cells are scattered in this part but some areas as large as a low-power field are cancer-free; C, Muscularis completely destroyed between these points; D, Vessels showing endarteritis. (× 3.)

A further possibility is that the peptic ulceration may be so rapid that the whole of the growth is destroyed. This has been put forward without much evidence by Morley Roberts (1926), who went so far as to suggest that every gastric ulcer is "a natural operation on a potential cancer." Duplant (1898) states that Tripier and Bard have seen cases of gastric ulcer whose cancerous nature was only demonstrable by the examination of metastases, the primary growth having been ulcerated away. He gives no further details or reference. Wilensky and Thalhimer (1918) described a case which both macroscopically and microscopically appeared a simple chronic peptic ulcer on the lesser curvature of the stomach. There was also a deposit of carcinoma in a neighbouring lymph-gland. They explain this as a case of maximum destruction of the growth with ulcer formation and the only evidence of the primary carcinomatous nature of the stomach lesion the metastatic growth in the gland. They give no clinical details, and a very weak spot in their argument is that the cancer was squamous-celled, a type which extremely rarely is primary in the stomach.

Several of the cancers of the intestine show the up-turning of the muscular coat into the floor of the lesion similar to that seen in chronic ulcer. One is illustrated in *Fig.* 132. It is quite clear in this case that it is due to contraction of the subserous fibrous tissue pulling the two halves of the ulcer together and so everting the edges of the muscularis. It has nothing to do with peptic ulceration.

FIG. 132.—Carcinoma of jejunum. A rather scirrhous growth. The muscle is completely destroyed in centre of ulcer and its edges are upturned owing to the contraction of the fibrous tissue formed in the subserous region. The growth is spreading in the submucosa separating the muscularis mucosæ and muscularis. (× 3.)

c. Endarteritis or thrombophlebitis was present in 72 per cent of gastric ulcers. It is also present in 16 per cent of cancers of the intestine. It is, therefore, of little value as a diagnostic point in ulcer-cancer.

d. In the relationship between the muscularis mucosæ and muscularis we have a diagnostic point of great importance (*see Figs.* 131, 132). Fusion or close approximation of these layers was present in some part of 98·8 per cent of the peptic ulcers in this series. The two cases where it was absent were in the stage of rapid extension all round the ulcer, a very rare condition. In all the other gastric ulcers definite signs of healing were taking place with fusion or approximation of the muscularis mucosæ and muscularis. Stewart (1928 and 1929), while agreeing that if fusion be " present in association with carcinoma assuredly the latter is secondary even although there may be considerable infiltration of the floor ", objects that fusion is an indication of healing rather than of chronicity. But what is fibrosis ? Surely fibrosis on which he rightly lays great stress is also an indication of healing rather than chronicity. He further states that he has numerous specimens of uncomplicated chronic ulcer in which the muscularis mucosæ and muscular coat are widely separated. In this series no case occurred where they were separated widely.

In the intestinal carcinoma group the muscularis mucosæ and muscularis were widely separated in 94 per cent, unchanged in 6, and in no case were they approximated or fused. It would appear, then, that fusion is the only one of these four points which is absent in all the cases of carcinoma of the intestine ; it is present in all the cases of healing peptic ulcers, and it is therefore suggested that it is the most important point in the histological diagnosis of the pre-existence of peptic ulcer.

2. **Evidence of Cancer.**—The diagnosis of malignancy of a tumour in the stomach is no different from its diagnosis in other organs. The best evidence is the presence of metastatic growth in glands or elsewhere. This is definite proof of malignancy when present, but in most cases will not have occurred. It is, therefore, not of much practical value.

Usually it is necessary to fall back on the more debatable grounds of variation in appearance and arrangement of individual cells and local

infiltration. The following points should be considered. Atypical arrangement of cells in solid masses or columns instead of in tubes or acini; variation in size and shape, especially the formation of polygonal or polyhedral instead of cubical or columnar cells; variation in nuclei, including their central position and hyperchromatism; a large number of mitotic figures, especially if they are abnormal. All are points in favour of malignancy, but any may be present in rapidly regenerating epithelium. Many of them taken together would strongly suggest malignancy and necessitate a careful examination of other sections for further evidence.

FIG. 133.—Edge of chronic gastric ulcer in healing stage. (× 3.)

Infiltration of other tissues by epithelium is usually accepted as evidence of malignancy, but it is necessary to be certain that the epithelium is growing into the tissue and not merely misplaced as the result of congenital defect or from irregular healing. Heterotopic epithelium is not carcinoma. It is usually arranged in definite tubes or acini. The cells are regular with basal nuclei. In this connection care must be taken not to confuse oblique cutting of a tube with heaping up of epithelium. *Figs.* 133–135 illustrate this point well.

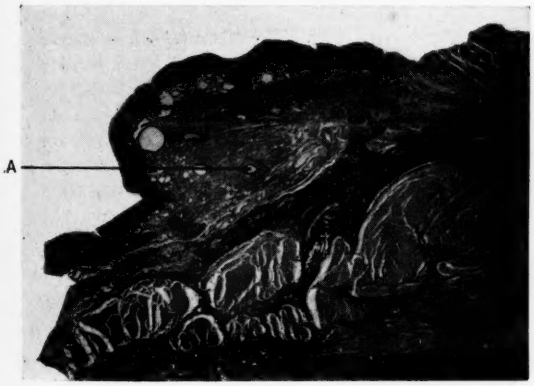


FIG. 134.—Edge of chronic gastric ulcer in healing stage, showing heterotopic epithelium (A) in dense fibrous tissue. (× 10.)

It is probable that some of the high figures given for the proportion of cancer arising in ulcer are caused by mistaking this heterotopic epithelium for cancer. In this series it was present in 44 of 161 ulcers, or nearly 28 per cent. Dible (1925) found it in 32 per cent of his series, and Taylor (1927) in 22 per cent. If it had been taken as evidence of carcinoma in this series, it would have brought the number of ulcer-cancers up to 50, and the percentage of carcinoma arising in ulcer would be 55·5, and that of ulcers becoming malignant 31.

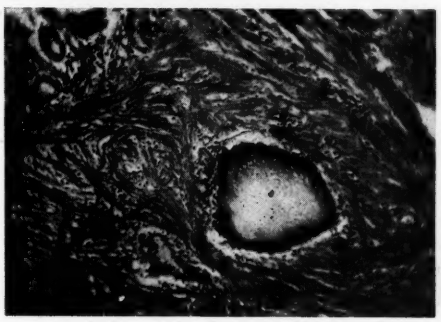


FIG. 135.—The alveolus marked A in *Fig.* 134 under higher magnification. The epithelium appears to be several layers thick, but serial sections showed that this was owing to oblique cutting of edge of alveolus. (× 100.)

To summarize: for the histological diagnosis of ulcer-cancer, there must

be definite evidence of both carcinoma and of pre-existing peptic ulcer. The only definite evidence of the latter not given occasionally by primary carcinomata is fusion of the muscularis mucosæ and muscularis at the edge of the ulcer. It is suggested that the presence of this criterion is as valuable as the demonstration of tubercle bacilli in the diagnosis of tuberculosis.

APPLICATION OF CRITERIA TO THIS SERIES.

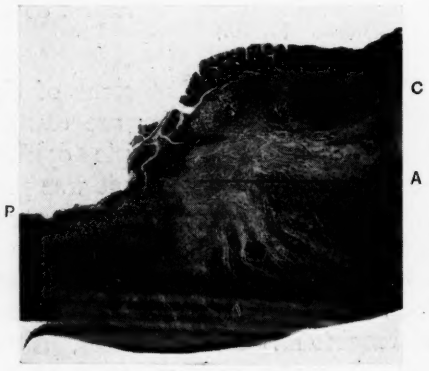
Applying the criteria to this series there are only six cases which are definitely carcinoma arising in pre-existing peptic ulcer. They will be considered in detail.

Case 1 (*Figs.* 136, 137).—Male, age 33, admitted with 5 years' history of pain half an hour after food, relieved by vomiting. He was diagnosed clinically as gastric ulcer. At operation an ulcer on the lesser curvature near the pylorus was found

FIG. 136.—*Case* 1. Ulcer-cancer of stomach. C and P mark cardiac and pyloric sides respectively. Small nodules of growth can be seen infiltrating the muscularis on the cardiac side. Fusion of muscularis mucosæ and muscularis is seen at A. (× 3·6.)

and carcinoma was not suspected until the microscopic sections were examined. Macroscopically the ulcer was 1·2 cm. in diameter, had hard raised edges, the lower one involving the pyloric ring. Microscopically the section shows a typical chronic

FIG. 137.—*Case* 1. The cardiac side of specimen shown in *Fig.* 136 with higher magnification. Fusion of muscularis mucosæ and muscularis is seen at A. Infiltration of the muscle by the cancer is shown just below this. (× 12.)



peptic ulcer. The muscularis is completely destroyed in its base, where there is a large fibrous mass. Fusion of muscularis mucosæ and muscularis is shown at both edges, and several vessels with endarteritis are present. On the cardiac side of the ulcer there is a mucous carcinoma which is definitely invading the muscularis.

Case 2 (*Figs.* 138–141).—Male, age 53. History of eight to nine years' attacks of 'catarrh of stomach'; six months' flatulence and feeling of fullness; seven

weeks' frequent vomiting. Loss of weight; no appetite. At operation an ulcer was found on the lesser curvature towards pyloric end. Wedge resection performed. Macroscopically a wedge-shaped portion of stomach involving 7 cm. of lesser curvature. An ulcer 2 cm. in diameter with raised edges occupies its centre. Half the specimen is seen in the coloured drawing (*Fig.* 138). Microscopically, an ulcer with carcinoma in its edges and base. In one section only there was complete destruction of the muscle. There is much fibrosis around and in the base, but it is infiltrated with carcinoma of an undifferentiated polygonal-celled type. Many vessels showing endarteritis are present and fusion of muscularis mucosæ and muscularis at the edges. Owing to this last fact it is placed in the ulcer-cancer group in spite of the presence of muscle in the base of the ulcer in most sections and the infiltration of the base with carcinoma.

FIG. 138.—*Case* 2. One half of an ulcer-cancer of the stomach. The cut surface is close beside and parallel to the lesser curvature. (× ⅔.)

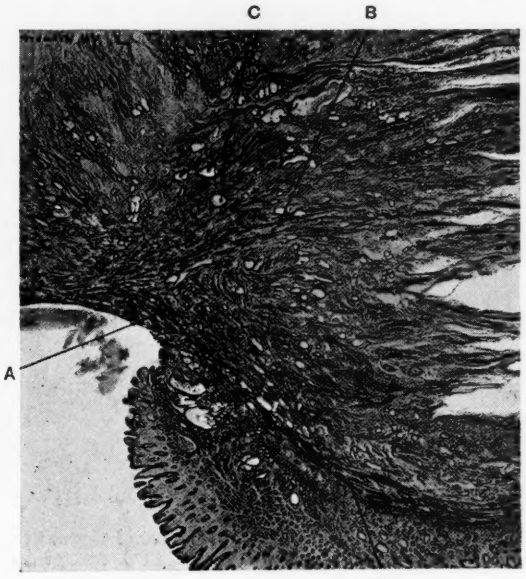


FIG. 139.—*Case* 2.—Microphotograph (retouched) of edge of ulcer. At A the fusion between muscularis (B) and muscularis mucosæ (D) can be seen. C, Acini of carcinoma invading muscle. (× 24.)

FIG. 140.—*Case* 2. Edge of ulcer-cancer showing fusion of muscularis mucosæ and muscularis, and invasion of muscle by the growth. (× 12.)

FIG. 141.—*Case* 2. A portion of *Fig.* 140 under higher magnification to show a group of cancer cells in a lymphatic. (× 100.)

Case 3 (*Figs.* 142, 143).—Male, age 53. History of three years' attacks of pain in epigastrium soon after food; one year vomiting after evening meal. The

vomiting relieved the pain. At operation chronic peptic ulcer on posterior wall reaching lesser curvature. Macroscopically, ulcer 2 cm. in diameter on posterior wall of stomach extending to lesser curvature 5 cm. from pylorus. Irregular hard edge slightly overhanging. Microscopically, the general appearance is that of a peptic ulcer

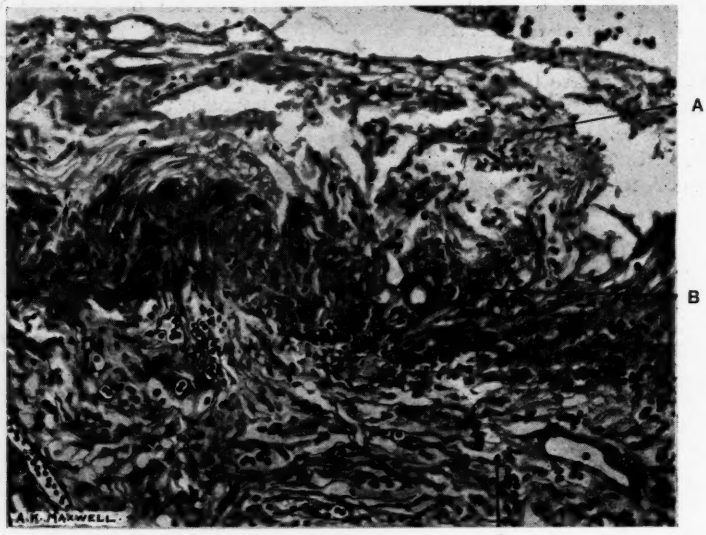


FIG. 142.—*Case* 3. Ulcer-cancer of stomach. Section from centre of ulcer crater showing fibrinous (A), necrotic (B), and granulation-tissue (C) layers. (× 200.)

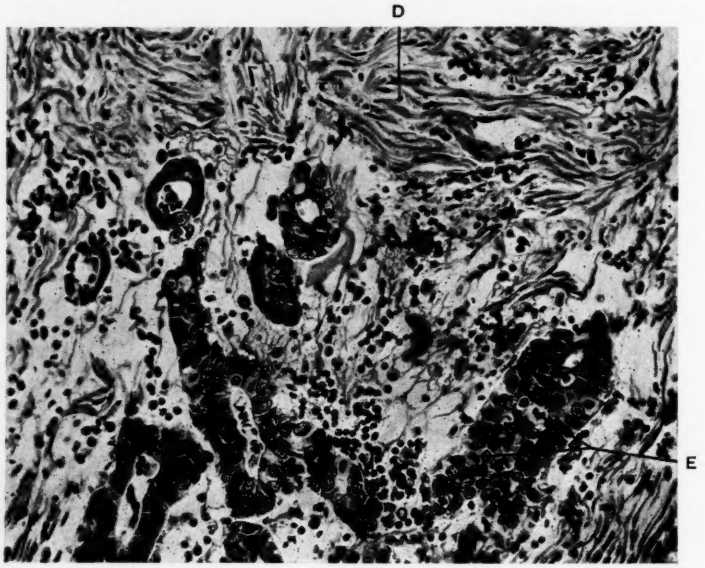


FIG. 143.—*Case* 3. Ulcer-cancer of stomach. Actively growing carcinoma deep to fibrous layer D. Mitotic figures shown at E. (× 200.)

with much active digestion, the typical layers being well shown. The muscle is completely destroyed, and there is much fibrosis between its edges. Several vessels showing endarteritis are present. Approximation of the muscularis mucosæ and muscularis is shown on one side of the ulcer. On the same side there is a columnar-celled adenocarcinoma invading the muscularis. Numerous mitotic figures are present.

Case 4 (*Figs.* 144, 145).—Female, age 30. History of six years' attacks of pain in epigastrium, half an hour after food. Three years ago X-rayed, and penetrating ulcer of lesser curvature seen. Improved with medical treatment for a year. For

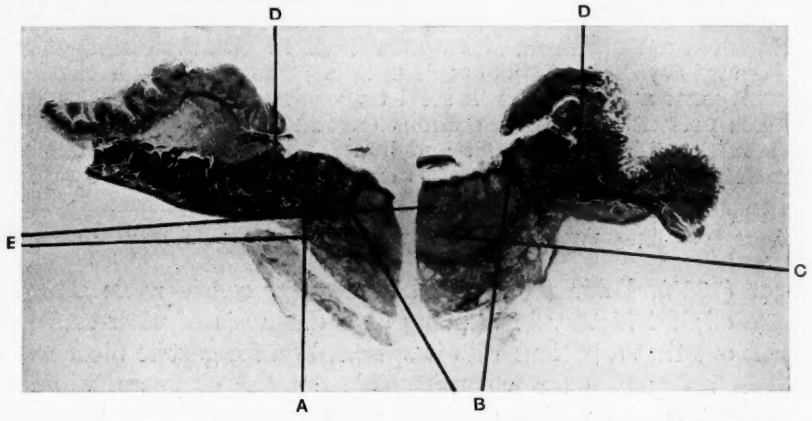


FIG. 144.—*Case* 4. Ulcer-cancer of stomach. A, Carcinoma on one side of ulcer only. B, Area in which muscularis is destroyed; C, Area of dense fibrosis; D, Points of fusion between muscularis and muscularis mucosæ; E, Vessels with endarteritis. (× 3.)

twelve months has become progressively worse. Five months' constant vomiting. At operation annular growth of pyloric antrum ulcerated on lesser curvature. Partial gastrectomy. Macroscopically, 10 cm. of pyloric end of stomach with annular growth in pyloric canal. Ulcer 2 cm. in diameter on lesser curvature. Microscopically, tubular and trabecular columnar- and polygonal-celled carcinoma arising in peptic ulcer. The growth is only on one side of the ulcer. The muscle is completely destroyed. Much fibrosis partly cancer-free in base of ulcer. Endarteritis of small vessels present. Fusion of muscularis mucosæ and muscularis present.

FIG. 145.—*Case* 4. Edge of ulcer seen in *Fig.* 144 showing carcinoma and fusion of muscularis mucosæ and muscularis. (× 12.)

Case 5.—Female, age 56. Admitted with a history of three and a half years' indigestion, for which she took sod. bicarb., which relieved the pain. One year vomiting, wasting, and worse pain. At operation ulcer (? growth) on posterior surface adherent to pancreas. Several enlarged glands in omentum. Macroscopically, 1 cm. of duodenum and 12 cm. of stomach. Hole 1 cm. in diameter surrounded by ulcer on posterior surface near lesser curvature 4 cm. from pylorus. Microscopically, a mucous carcinoma arising in a chronic peptic ulcer. The carcinoma only involves one side of the ulcer, which shows active digestion in the centre. The muscle is completely destroyed and replaced by fibrous tissue. Vessels showing endarteritis are present and fusion of muscularis mucosæ and muscularis on both sides of the ulcer.

This and the previous one were the only two cases confidently diagnosed by the naked eye and by the surgeon as carcinoma.

Case 6.—Male, age 47. Admitted for abdominal pain of nine to ten years' duration. Treated medically for seven to eight years. For two years pain worse, and for eighteen months appetite gone since removal of teeth. Lying down relieves

pain, which has no relation to food. No vomiting. At operation chronic ulcer of lesser curvature adherent to pancreas. Macroscopically, pylorus and portion of stomach with ulcer 2 cm. in diameter on lesser curvature. Cardiac side overhanging. Microscopically, a chronic peptic ulcer, recently active. The muscle is completely destroyed and replaced by dense fibrous tissue. Endarteritis present in several vessels. Fusion of muscularis mucosæ and muscularis. On the overhanging cardiac side there is much atypical epithelial proliferation. The cells vary in size and shape. Many are polygonal and arranged in solid trabeculæ. Hyperchromatic nuclei and mitotic figures present. The first sections examined showed no definite signs of carcinoma; further blocks were cut and infiltration of lymphatics demonstrated. This is the only case where the diagnosis of carcinoma presented any difficulty.

DURATION OF SYMPTOMS.

Stewart (1929), Dible (1925), and others lay considerable stress on the value of the clinical history in arriving at a diagnosis of ulcer-cancer. They rightly point out that a patient who is operated on for gastric ulcer has usually suffered from indigestion for a considerable number of years, while in their experience most cancer patients have a short history. They both go so far as to exclude certain cases from their ulcer-cancer group owing to the short history. This would seem to indicate a lack of faith in their histological criteria.

The possible fallacy in stressing the clinical history is well shown in one case. A man, age 50, commenced his illness by having hæmatemesis in 1920. After this he suffered from attacks of abdominal pain. In 1923 he was admitted to hospital and a laparotomy was performed. The stomach and duodenum were normal and his appendix was removed. As the pain recurred he was again operated on in 1925, and a typical chronic peptic ulcer on the lesser curvature was excised. Did his symptoms date from 1920 or 1923?

In obtaining clinical histories for the series of cases here described there has been considerable difficulty. In most instances the notes in the hospital records were written by junior dressers and points of great importance were omitted. One of the worst difficulties was the habit of starting the history with a previous operation. In several cases it was impossible to find out why the first operation was performed and the length of illness prior to it. In a few cases I have personally seen patients with short histories and have been told, "of course I have had indigestion all my life," when the dresser had recorded "three months' pain after food" and "previous history good". However, the best histories available have been obtained and are shown in *Table VI.*

Table VI.—Duration of Symptoms in Months at Time of Operation.

	Ulcer	Cancer	Cancer Corrected	Ulcer-Cancer
Shortest ..	2	1	1	36
Average ..	112	39	9	71
Longest ..	480	540	48	114

In the carcinoma group there are four patients who all dated their illnesses for comparatively short times, but who have recorded under 'previous illnesses' a long period of indigestion, in one case lasting for forty-five years. Two sets of figures, therefore, are given in the table, the first showing the duration from the onset of indigestion and the second from the commencement of the symptoms for which the patient was admitted to hospital.

Counting the four cases mentioned above, nine of those included in the primary carcinoma group have histories lasting for three years or over. The other thirty-one all dated the onset of their symptoms within two years of operation. Of the nine cases eight presented none of the four histological criteria of pre-existing peptic ulcer mentioned above and are definitely ulcerated cancers. The ninth is a case with considerable difficulty and is described in full.

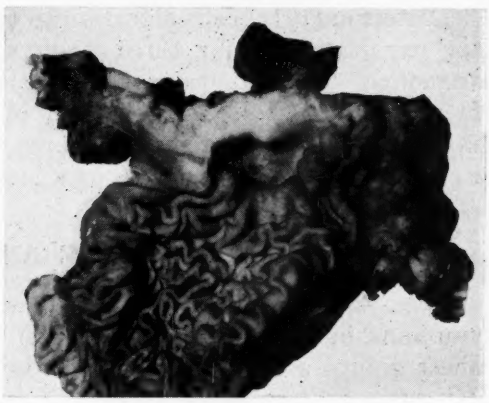


FIG. 146.—*Case* 7. Ulcerated carcinoma of stomach. The anterior half of piece of stomach removed at operation. A double crater is shown on the lesser curvature and there is complete destruction of the muscle by the cardiac crater. (× ½.)

Case 7.—A man, age 47, came to hospital for hæmatemesis and melæna. He had a history of two years' pain and vomiting after food. After a few weeks' rest he was radiographed and an ulcer with a double crater and thick edges was seen on the lesser curvature. It was reported 'strongly suggestive of carcinoma'. As, however, the pain and vomiting had now disappeared he refused a laparotomy and went home. He was readmitted ten months later with a return of symptoms. A second radiogram showed very little change in the ten months. Laparotomy was performed and a large piece of stomach removed. On examination a double ulcer 4·2 cm. × 3·5 cm. was found on the lesser curvature as described by the radiologist, and the raised edges strongly suggested carcinoma (*Fig.* 146). Microscopically, the pyloric crater is a typical ulcerated carcinoma. The base contains muscle with scirrhous growth running between its fibres. The growth is spreading in the submucosa and separating the muscularis mucosæ from the muscularis (*Fig.* 147). In the adjoining crater the muscle is completely destroyed and replaced by fibrous tissue and growth. An area 0·3 cm. wide of fibrous tissue is free from growth. At the edges the muscularis mucosæ and muscularis are again separated. Several small vessels showing endarteritis obliterans are present.

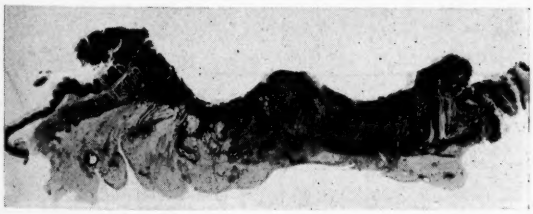


FIG. 147.—*Case* 7. Section of the same case showing pyloric crater to be a typical ulcerated carcinoma with peptic ulceration on its cardiac edge. The muscularis mucosæ is separated from the muscularis. (*Natural size.*)

Here, then, is a case where all the criteria for the diagnosis of ulcer-cancer are present except one—the fusion of muscularis mucosæ and muscularis. It is suggested that the growth started near the pylorus and that there was

later peptic ulceration on the cardiac side of it, destroying it and so allowing peptic digestion of the muscle in the region of the cardiac crater to take place. Fibrous tissue has then formed in the submucous region and by contracting has given the upturned appearance of the muscle. It seems that the histological appearance can be explained on the assumption that it was a primary carcinoma with secondary peptic ulceration.

Another interesting feature of the case is that it was possible by X rays to see the double ulcer ten months earlier in a condition similar to that in which it was found at operation. This suggests a very slow rate of growth for the carcinoma and so gives an explanation of the comparatively long history.

Paterson (1914) calls attention to two of his cases with very long histories. One remained well for three years after gastrojejunostomy for inoperable carcinoma. The second was alive four and a half years after a similar operation. He suggests that the natural history of gastric carcinoma is very variable and may be long. It is wrong to assume that a case of gastric carcinoma arose in an ulcer merely because it has a long history.

AGE AND SEX.

Age.—*Tables VII* and *VIII* show the age at operation and at onset of symptoms in the three groups. The numbers in the carcinoma and ulcer-cancer groups are obviously much too small to warrant any conclusions, but they agree rather closely with Professor Stewart's and show that ulcer-cancer is intermediate in age between ulcer and cancer.

Table VII.—Age in Years at Operation.

	Ulcer	Ulcer-Cancer	Carcinoma
Youngest ..	22	30	33
Average ..	44·6	45	45
Stewart's average	44	48	50
Oldest	66	56	72

Table VIII.—Age in Years at Onset of Symptoms.

	Ulcer	Ulcer-Cancer	Carcinoma	Corrected Carcinoma
Youngest	16	28	16	33
Average	35	40	52	54
Stewart's average ..	36½	41½	49	—
Oldest	63	53	71	71

Sex.—In the six cases of ulcer-cancer here recorded 4 were males and 2 females. Stewart records 9 males to 2 females. Cabot and Adie's 5 cases were all males. Dible's were male and female. Adding these together: of

24 cases, 19 were males and 5 females. The number of cases is obviously too small to allow of any definite conclusions, but they do suggest a greater frequency of ulcer-cancer in the male.

FREQUENCY OF ULCER-CANCER.

Estimates of the frequency of ulcer-cancer can be made in two ways: the proportion of cases of carcinoma of the stomach which arise in peptic ulcers, or the proportion of cases of peptic ulcer which become carcinomatous. The conclusions of 102 observers of the first percentage are shown in *Fig.* 117 (p. 281) and in the Appendix (p. 305). The extreme variations are probably due to lack of definite criteria on which to base the diagnosis of ulcer-cancer. Some of the figures are based on clinical examinations, some on radiological, some on histories, only comparatively few on exact morbid anatomical studies. Even with the most definite histological criteria the figures obtained can only apply to a selected group of cases, either those coming to operation or those coming to post-mortem. These considerations apply even more strongly to estimates of the second kind—the percentage of cases of peptic ulcer becoming carcinomatous.

The figures in this series are shown in *Table IX*, Stewart's figures again being given for comparsion.

Table IX.—Frequency of Ulcer-Cancer.

		Stewart
Total cases of peptic ulcer	160	180
Total cases of carcinoma	46	70
Total cases of ulcer-cancer	6	11
Percentage of ulcers becoming cancer	3·75	6·1
Percentage of carcinoma arising in ulcer ..	13	15·7

It is important to keep clearly in mind the significance of these figures. They cannot be applied to the general population but only refer to a very limited group—namely, those whose ulcers have been excised. This group only includes a fraction of the cases admitted to hospital and takes no notice of those treated medically or by gastrojejunostomy. During the period 1920 to April, 1931, there were admitted to St. Mary's Hospital 731 cases of gastric ulcer, of which only 160, or rather more than one-fifth, are considered in this series: 339 cases of gastric carcinoma were admitted in the same period, and in only 46 (about one-seventh) was surgical removal performed. Again, in each clinic where similar estimations are made, the figures will depend on the method of selection of cases for operation, and whether excision is the routine treatment. Orator (1925) estimated in his series that 30 per cent of ulcers in the prepyloric region had become cancerous, while only 2 per cent in the rest of the stomach had become so changed. Finsterer (1925) pointed out that a higher proportion of cases of cancer is present among hard callous ulcers than among softer ones. Some surgeons only remove callous ulcers, and others only those near the pylorus. Both of them will have a higher percentage of ulcer-cancer than those who remove nearly all ulcers operated upon. The majority of the cases considered in this paper come from one surgeon whose routine treatment of gastric ulcers is excision, and consequently the percentage of ulcer-cancers is comparatively low.

Hauser (1926) has collected statistics from several German workers who have published estimates of the frequency of ulcer-cancer based upon morbid anatomical considerations. It is reproduced here (*Table X*).

Table X.—Frequency of Ulcer-Cancer.

Observer	Ulcers	Ulcer-Cancers	Percentage
Scheuerman (München) ..	96	1	1
Berthold (Berlin)	294	4	1·3
Wolowelsky (Basel)	139	2	1·4
Cohn (Kiel)	295	6	2·0
Greiss (Kiel)	136	4	2·9
Schneider (München)	89	3	3·4
Brinkman (Kiel)	725	40	5·5
Total	1774	60	3·4 (Average 2)

These figures agree with most of the rather conservative estimates made by other morbid anatomists such as Dible (1925), who found 1·7 per cent in 128 ulcers, and Kummer (1919) with 2 per cent in 357 ulcers. Ewing (1918) gives a good historical review and critical examination of the various criteria proposed by numerous authors. He gives no figures of his own, but concludes that the cancerous change does not take place in more than 5 per cent of ulcers.

Very different figures have been given by the pathologists of the Mayo Clinic, who consider that the majority of ulcers removed surgically are undergoing malignant change. These views will be considered critically later.

Attempts to estimate the frequency of ulcer-cancer have been made by tracing the after-history of cases treated by gastrojejunostomy or after perforation of peptic ulcers. Paterson (1914) estimated that only 1 per cent subsequently developed carcinoma. Greenough and Joslin (1899) found 1 in 112 cases, and Bamberger (1909) collected 22 in 1025 gastrojejunostomies or 2·1 per cent. These figures, however, do not prove that the carcinoma developed in the pre-existing ulcer, and cannot be accepted without reservation. Owen (1926) described the post-mortem on a man who died ten years after a gastrojejunostomy. He found an annular carcinoma of the pyloric antrum reaching up to but not including the scar of a healed peptic ulcer on the lesser curvature, but there was no evidence that the growth started in the ulcer. I have seen a similar case at post-mortem five years after a gastrojejunostomy. In this case the scar and growth were quite distinct.

In the series described here one case showed both an early carcinoma near the pylorus and a typical chronic peptic ulcer on the lesser curvature. They were widely separated by normal stomach mucosa, and no evidence exists that they had any connection with each other. It is quite clear, then, that proof of carcinoma occurring in a stomach known to have contained an ulcer is not proof that the carcinoma originated in the ulcer.

CRITICAL EXAMINATION OF LITERATURE.

In reading the voluminous literature on this subject two points are at once noticeable. First the large number of obvious errors, arithmetical and otherwise. In many cases percentages are incorrectly calculated, while in others charts do not correspond with the figures given in the text. Cabot and Adie (1925), in their otherwise excellent paper, make both these mistakes. They refer to 50·6 per cent of 82 observers, which presumably means 41½. Their chart referring to the same 82 observations is drawn in a similar way to *Fig.* 117. Only one observer estimates a percentage of 91 to 100, and so the unit can be measured. Applying this unit to the other parts of their curve, the total number of observers works out at 133 instead of 82. Another common error is misquotation of previous papers and incorrect references. This was a source of considerable annoyance in the compilation of the chart in *Fig.* 117. Secondly, in very few papers is it possible to find the author's criteria of ulcer-cancer. In some the diagnosis appears to rest on the history, in others it is radiological, while in many papers those diagnosed histologically are not separated from others diagnosed only on the macroscopic structure.

It is obviously only possible to consider a few of the more important papers in detail.

MacCarty, of the Mayo Clinic, has published a long series of papers on this subject. In 1909, with Wilson, in the *American Journal of the Medical Sciences*, he enumerated 218 cases :—

	Cases
Duodenal ulcer	8
Simple gastric ulcer	47
Carcinoma on ulcer	109
Some evidence of pre-existing ulcer	11
No evidence of ulcer	33
Sarcoma	2
Adenoma	2
Diverticulum	1
Possible transition cases	5
Total	218

Then in 1914 he publishes another paper with Broders, based on 684 cases, including the 218 previously reported. These he classifies :—

	Cases
Simple ulcers	191
Ulcer + carcinoma	472
Ulcer + doubtful carcinoma	21
Total	684

In the five years between 1909 and 1914, 2 sarcomas, 2 adenomas, a diverticulum, and 33 cases with no evidence of ulcer have been reclassified. He gives no explanation at all of this. He gives the protocols of 12 cases of carcinoma in ulcer. One case from the photograph of the macroscopic specimen might be an ulcer-cancer, but the others look more like ulcerated primary cancer. The microphotographs are too poorly reproduced to criticize. In some cases the histories are used for diagnosis, in others they are completely discounted.

In April, 1927, he complains of misquotation and false understanding and quotes the same figures from his previous papers, again making no attempt

to explain the discrepancies referred to above. He states that his diagnosis is now based largely upon frozen sections of unfixed tissues, and that this method is more reliable than fixed paraffin sections.

It is impossible to answer this last statement without a much more extensive experience of frozen sections of unfixed tissues than I possess, but in this respect a paper from Rochester, N.Y., by W. J. Scott (1928), is of interest. He describes an ulcer on the lesser curvature associated with a nodule on the duodenum. With fresh frozen sections the pathologist reported the ulcer benign and the duodenal nodule malignant. Later paraffin sections of the fixed tissues showed the ulcer malignant and the duodenal nodule to be ectopic pancreatic tissue. Such a report from the other Rochester gives rise to a feeling of doubt as to the trustworthiness of MacCarty's observations.

C. D. Aaron (1921) writes that Albert Kocher states that he has personally examined the Mayos' specimens and is convinced that much of what they labelled cancerous degeneration of ulcers was in reality merely atypical proliferation of epithelium. He gives the reference—" Chronic and Duodenal Ulcer, *Correspondenz-Blatt für schweizer Aerzte*, Basel, May 10th, 1919, No. 19 ", which is incorrect. The correct reference, if any, has not been found, and consequently the statement cannot be confirmed, but it seems the most likely explanation of the high figures coming from the Mayo Clinic.

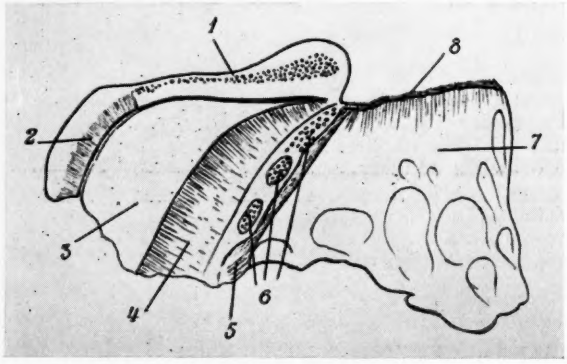


FIG. 148.—Copy of *Fig.* 123 from Pauchet and Hirchberg's book, *Cancer d'Estomac*, showing fusion of muscularis mucosæ and muscularis at edge of ulcer.

Of the papers where histological details are given, Dible's (1925) is one of the most complete. There seems little doubt that the two cases he accepts are definite ulcer-cancers. He also described three other cases which he considered might be ulcer-cancers from their histological appearance, but discarded them owing to their short clinical histories. As far as can be seen from his pictures, they would not fit in with my criteria, but it is remarkable to find a pathologist who has more faith in clinical histories than his own microscopical findings.

The importance of fusion of the muscularis mucosæ and muscularis in the histological diagnosis of ulcer-cancer was first brought forward by Professor H. M. Turnbull in his lectures at the London Hospital. It was demonstrated at the Royal Society of Medicine and briefly reported in the *Lancet* (Newcomb,

1925), and Stewart (1929) discusses it. No one else appears to have recognized its importance, although it can be seen in one of Dible's illustrations and in two cases described by Hirchberg (1928). A photograph of a diagram from his book is reproduced in *Fig.* 148. It is curious that in spite of illustrating it, he does not mention it in the description,

It had been hoped to apply the criterion of fusion of muscularis mucosæ and muscularis to the cases described by other workers on this subject, but in no paper were sufficient histological details given for this to be done.

SUMMARY.

1. The wide diversity of opinion with regard to the etiological relationship between peptic ulceration and gastric carcinoma has been pointed out.

2. It is suggested that this has arisen from a lack of definite histological criteria for the diagnosis of ulcer-cancer.

3. Four histological criteria for the diagnosis of ulcer-cancer have been considered and applied to control groups of 249 peptic ulcers and 100 carcinomata of intestine.

4. The great importance of fusion between the muscularis mucosæ and muscularis at the edge of the ulcer in this diagnosis has been pointed out.

5. Application of this test to a series of cases shows that 3·75 per cent of ulcers showed malignant change and 13 per cent of the cancers showed evidence of previous peptic ulceration.

My grateful thanks are due to my old chief, Professor H. M. Turnbull, for his teaching, without which this paper would never have materialized, and also to the Surgical Staff of St. Mary's Hospital, and in particular Professor C. A. Pannett, for providing the material on which it is based.

APPENDIX.

List of percentages of cases of carcinoma of stomach estimated by various authors as having arisen in pre-existing peptic ulcer. The figures in brackets after the percentage represent the total number of cases studied by that author.

Year.	Per cent.	Observer and Reference.
1890	0	Kollmer (*Berl. klin. Woch.*, 1890, v, 119 and 146).
1897	0 (59)	Krokiewicz (*Wien. klin. Woch.*, 1897, 1127).
1898	0	Duplant (*Thèse de Lyon*, 1898, No. 132).
1904	0 (66)	Peterson and Colmers (*Beitr. z. klin. Chir.*, 1904, xliii, 1).
1904	0	Pförringer (*Wachstum des Magencarcinoms, Ibid.*, 1904, xli).
1906	0	R. Schmidt (*Mitteil. a. d. Grenzgeb. d. Med. u. Chir.*, 1906, xv, 701).
1914	0	Paterson (*Surgery of the Stomach*, 2nd ed., 1914, 276).
1922	0	F. Peyser (*Deut. Zeits. f. Chir.*, 1922, clxviii, 404).
1923	0 (50)	Duggan (*Boston Med. and Surg. Jour.*, 1923, clxxxix, 471).
1928	0	Izod Bennett (*Brit. Med. Jour.*, 1928, i, 170).
1901	1 (361)	Borrmann (*Mitteil. a. d. Grenzgeb. d. Med. u. Chir.*, 1901, 2).
1848	1·2 (160)	Dittrich (*Vierteljahr. f. d. prakt. Heilkunde*, 1848, xvii, 1).
1913	1·2	Gruber (*Zeits. f. Krebsforsch.*, 1913, xiii).
1890	2	Eichhorst (*Handb. d. spez. Pathol.*, 4 Aufl. Bd. 2, 136).
1904	2·2	Cooper and Shaw (*Guy's Hosp. Rep.*, 1904, xliii, 121).
1901	2·6	Osler (Osler and McCrae, *Principles and Practice of Medicine*, 10th ed., 495).

Year.	Per cent.	Observer and Reference.
1909	2·3	Bamberger (*Die Innere und die chir. Behand. des chr. Magengeschwürs.* Berlin).
1918	2 (48)	Wilensky and Thalhimer (*Ann. of Surg.*, 1918, lxvii, 215).
1929	2·7	Pettinari, V. (*Tumori*, 1929, xv, 248, etc.).
1859	3	Plange (Dissert. Inaug., Berlin, 1859, quoted by Rosenheim).
1883	3	Berthold (Dissert. Inaug., Berlin, 1883, quoted by Rosenheim).
1889	3	H. Häberlin (*Deut. Arch. f. klin. Med.*, 1889, xliv, 461).
1902	3	Fenwick (*Cancer and other Tumours of Stomach*, 102).
1911	3–7	Lockwood (*Jour. Amer. Med. Assoc.*, 1911, lvi, 951).
1913	3–5	Konjetzny (*Beitr. z. klin. Chir.*, 1913, lxxxv, 455).
1920	3–5	Anschütz (*Deut. Zeits. f. Chir.*, 1920, cliv, 1).
1928	3·5	De Vecchi (*Arch. ital. di Chir.*, 1928, xxxi, 1).
	3·3 (331)	Herschenson (quoted by Pettinari).
	3–5	Winternitz (quoted by Poscharissky).
1868	4	Steiner (Dissert. Inaug., Berlin, 1868, quoted by Rosenheim).
1868	4	Wollmann (Dissert. Inaug., Berlin, 1868, quoted by Rosenheim).
1902	5 (228)	Riechelmann (*Berl. klin. Woch.*, 1902, xxxix, 728).
1907	5 (176)	Redlich (*Zeits. f. Krebsforsch.*, 1907, v, 261).
1915	5	Max Einhorn (*Jour. Amer. Med. Assoc.*, 1915, lxv, 1230).
1927	5	Stanley Wyard (*Diseases of the Stomach*, 329).
1902	5·6 (159)	Borst (*Lehr. von den Geschwülsten*, Wiesbaden, 1902, quoted by Pettinari).
1882	6·1	Danielsen (Inaug. Diss., Würzburg, 1882, quoted by Poscharissky).
1901	6 (241)	Borrmann (*Mitteil. a. d. Grenzgeb. d. Med. u. Chir.*, 1901, 2).
1912	6·8	Perthes (*Münch. med. Woch.*, 1912, lix, 2140).
	6·8	Altschul (quoted from Pettinari).
1925	6	Dible (*Brit. Jour. Surg.*, 1925, xii, 666).
1928	6	Bastianelli (*Report of International Conference on Cancer*, 1928, 355. London).
1913	7 (60)	Saltzmann (*Studien über Magenkrebs aus dem Univ. Helsingfors*, 1913. Jena).
1914	7·3 (1000)	Friedenwald (*Amer. Jour. Med. Sci.*, 1914, cxlviii, 660).
	7	Casolo (quoted by Pettinari).
1890	8 (50)	Rosenheim (*Zeits. f. klin. Med.*, 1890, xvii, 116).
	8·2	Menne (quoted by Poscharissky).
	8·5	Petren (quoted by Anschutz and Konjetzny).
1878	9	Lebert (*Krankheiten des Magens*, 1878, 440. Tübingen).
1925	9	Cabot and Adie (*Ann. of Surg.*, 1925, lxxxii, 86).
1926	10	J. S. Lawrence and Boch (*Boston Med. and Surg. Jour.*, 1926, cxcv, 651).
1882	10–15	Litten (*Berl. klin. Woch.*, 1882, xix, 658).
1925	10–15	Orator (*Virchow's Arch.*, 1925, cclvi, 202).
	11·4	Eppinger (*Prager Vierteljahr*, cxiv, quoted by Welch).
1917	12·2 (43)	Fichera (*Tumori*, 1917, quoted by Pettinari).
1890	13 (38)	Hauser (*Das Cylinderepithel-carcinom des Magens*, 1890. Jena).
1912	13·3 (230)	Genzken (Inaug. Diss., Kiel, 1912, quoted by Konjetzny).
1892	14 (156)	Sönnichsen (*Zeits. f. klin. Med.*, 1892, xvii, 117).
1900	14·7 (163)	Tiemann (Inaug. Diss, Kiel, 1900, quoted by Konjetzny).
1914	15	Küttner (*Lang. Arch. f. klin. Chir.*, 1914, cv, 788).
1929	15·7	Stewart (Hurst and Stewart, *Gastric and Duodenal Ulcer*, 1929, 381).
1930	15	Poscharissky (*Zeits. f. Krebsforsch.*, 1930, xxxi, 263).
	15·6	Woloschin (quoted by Poscharissky).
1909	16 (662)	Haberfeld (*Zeits. f. Krebsforsch.*, 1909, vii, 190).
1910	16·5	Matti (*Deut. Zeits. f. Chir.*, 1910, civ, 425).
1895	17	Buttenberg (Inaug. Diss., Jena, quoted by Audistère).
1921	17	Taylor and Miller (*Amer. Jour. Med. Sci.*, 1921, clxii, 862).
1928	17·3 (98)	Duval and Moutier (*Bull. et Mém. Soc. nat. de Chir.*, 1928, liv, 423).
	18	Reimer (quoted by Audistère).
1896	19 (42)	Hemmerschlag (*Arch. f. Verdauungskrank.*, 1896, ii, 1).
	19	Miroljuboff (quoted by Poscharissky).
1931	(less than 20)	Walton (*Lancet*, 1931, i, 1072).
1929	20	Hurst (*Lancet*, 1929, ii, 1023).
	20	Rivier Jaboulay (quoted by Rodman).
1928	22 (94)	Hayem (*Presse méd.*, 1928, xxxvi, 1137).

Year.	Per cent.	Observer and Reference.
1900	26·7 (120)	Klausa (Inaug. Diss., Kiel, 1900, quoted by Hauser).
1904	26	Mazdl-Jedlicka (*Zur operat. Behand. des chron. Magengeschwürs*, 1904. Prague).
1922	26	Payr (*Arch. f. klin. Chir.*, 1910, xciii, 436).
1903	30	Stich (*Bruns. Beitr. z. klin. Chir.*, 1903, xl, 342).
1909	30	Riedel (*Deut. med. Woch.*, 1909, quoted by Payr).
1930	30	Finsterer (*Arch. f. klin. Chir.*, 1930, clix, 30).
1925	37	Finsterer (*Wien. klin. Woch.*, 1925, xxxviii, 295).
1928	37 (35)	Spriggs (*Report of International Conference on Cancer*, 1928, 335. London).
1919	over 40	C. H. Mayo (*Ann. of Surg.*, 1919, lxx, 236).
1923	41	Sherren (Choyce, *System of Surgery*, 2nd ed., ii, 393).
1908	50	Rodman (*Jour. Amer. Med. Assoc.*, 1908, l, 165).
1919	50	Deaver (*N.Y. Med. Jour.*, 1919, cix, 749).
1915	above 50	W. F. Cheney (*Jour. Amer. Med. Assoc.*, 1915, lxv, 1227).
1914	52–57	Wilson and McDowell (*Amer. Jour. Med. Sci.*, 1914, cxlviii, 796).
1906	54	Graham (*Boston Med. and Surg. Jour.*, 1906, clv, 193).
1907	54 (69)	W. J. Mayo (*Ann. of Surg.*, 1907, xlv, 810).
1907	59·3	Mayo Robson (*Cancer of Stomach*, Bradshaw Lecture).
	62	Paterson (quoted by Poscharissky).
1909	66·6	Moynihan (*Brit. Med. Jour.*, 1909, i, 830).
1917	66	Smithies (*Illinois Med. Jour.*, 1917, xxi, 149).
1910	67	Wilson and Willis (*Collected Papers of Mayo Clinic*, 1910, 118).
1914	68·6 (493)	McCarty and Broders (*Arch. of Internal Med.*, 1914, xiii, 208).
1909	71 (153)	Wilson and McCarty (*Amer. Jour. Med. Sci.*, 1909, cxxxviii, 847).
1920	75	Pauchet and Delort (*Presse méd.*, 1920, ii, 793).
1905	82 (50)	Mumford and Stone (*Surgical Aspects of Digestive Disorders*, 1905. New York).
1910	over 80	Mansell Moullin (*Lancet*, 1910, i, 415).
1900	over 90	Ssapeshko (*Annalen d. Russ. Chir.*, 1900, No. 6, quoted by Rodman).

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A REPORT ON THE STRANGEWAYS COLLECTION OF RHEUMATOID JOINTS IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS.

By R. LAWFORD KNAGGS,
With Photo-micrographs by G. H. RODMAN.

PART II.

SOME NATURAL FEATURES AND HISTOLOGICAL PECULIARITIES OF OSTEO-ARTHRITIS AND RHEUMATOID ARTHRITIS.

I. OSTEO-ARTHRITIS.

A. The Histology of Osteophytes.

1. The Development of an Osteophyte.—The present view of the origin of an osteophyte is that it is due to excitation of the adjacent medulla. Vascular cellulo-connective tissue, supposed to be an extension from the medulla,* appears in patches of softening, or in spaces arising from them, in the deep parts of the articular cartilage. The cartilage becomes honeycombed with these spaces, and the intervening cartilage is converted into bone by metaplasia.

There is no question that in an osteo-arthritic joint spaces filled with vascular cellulo-connective tissue appear in the deep layers of the articular cartilage, but the contents arise from proliferation of the connective-tissue basis of the cartilage and a reversion of the cartilage cells to the connective-tissue type. After the formation of these spaces the evolution of the osteophyte begins.

a. The cartilage bordering the spaces may undergo more or less calcification, and bone is developed in the cartilage or in the calcified parts of it by metaplasia.

b. The adjacent cartilage loses its cartilaginous appearance, changing into fibrocartilage or fibro-connective tissue, and additional spaces are outlined in it as calcification and ossification advance from the periphery of the developing osteophyte.

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* There is but little justification for this idea, for the adjacent medullary spaces are in some cases filled with fat only, and in others besides the fat there may be only a small development of proliferated connective tissue. Moreover, in some instances where the section is successful in demonstrating an aperture in the subchondral bone lamina connecting a medullary space with the spaces of a forming osteophyte, the change from fat medulla to the proliferated connective-tissue contents of the osteophyte spaces is apt to take place abruptly in the gap, which suggests that perforation has been effected from the osteophyte.

c. When the osteophyte ceases to advance, it becomes limited by a bony boundary, which is covered by cartilage, or, if the osteophyte reaches the surface, by a layer of fibrous tissue derived from the cartilage, and continuous eventually with the periosteum.

d. As the osteophyte grows, spaces form in its base by resorption, and as they enlarge the cancellous tissue and spaces of the osteophyte blend with those of the parent bone.

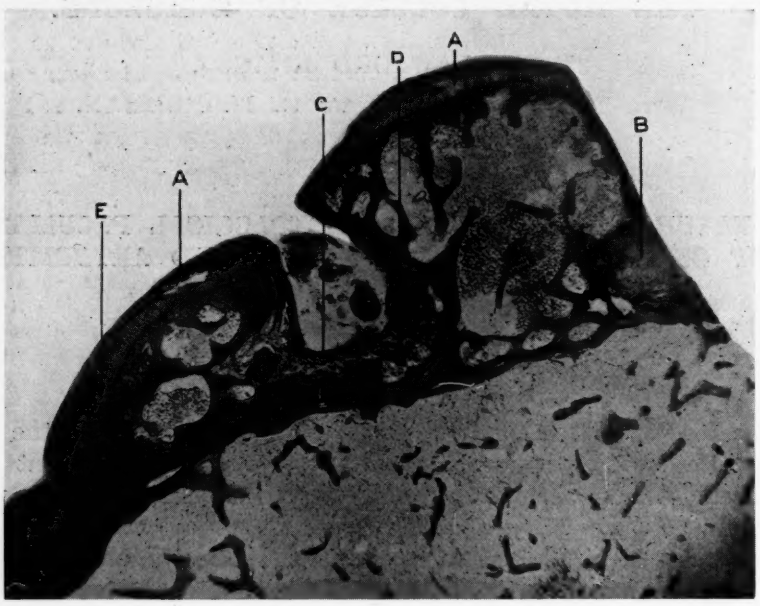

FIG. 149.—Osteo-arthritis. Section through a lumpy part of the articular surface of the head of a humerus of an old man. It was overlaid by the tendons of the spinati muscles and capsule, and it shows hypertrophic formations in various stages. A, Degenerating cartilage; B, Granulation tissue; C, Vascular fibrous tissue—cartilage transformed in the dividing sulcus; D, Granulation tissue eroding bone; E, Advancing ossification into cartilage. (*Specimen S.C.* 15–1.) (× 6.)

e. With the cessation of growth the fibrocellular contents tend to become fat marrow; but in many microscope sections activity is seen to persist at some part of the osteophytic periphery. (*Inflammatory and Toxic Diseases of Bone, Figs.* 72, 74–77, pp. 151 et seq.)

Spaces, apparently identical with those just described as being the forerunners of an osteophyte in osteo-arthritis, occur in rheumatoid arthritis, but in the latter affection they show a more pronounced partiality for the neighbourhood where the cartilage joins the bone.

Up to this point the change is common to both disorders, and I assume the same cause to be at work—namely, toxins. But beyond this point the pathological processes in the two affections progress upon divergent lines. Localized ossification, tending to the building up of osteophytes or their homologues, produces the hypertrophic formations of osteo-arthritis; but in rheumatoid arthritis inflammatory degeneration ends in the replacement of both bone and cartilage by fibrous tissue. These different responses to the

toxic damage are almost certainly determined by differences in the vitality of the tissues.

2. Certain Peculiarities of the Calcified Zone of the Osteo-arthritic Joint.—Histological features of some interest are associated with the development of

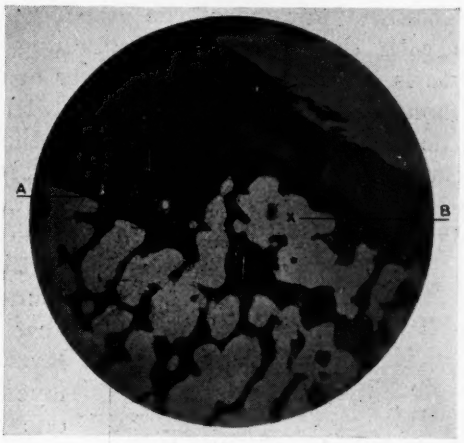

FIG. 150. — Osteo-arthritis. Section from the same femur and condyle as *Fig.* 156, showing an epiarticular osteophyte (B) near the centre of the transverse section of the condyle. A, Point of commencing bifurcation of the calcified zone. Note the bone on either side of the continuation of the normal calcified line. (× 8.)

osteophytes. Their occurrence, however, is only occasional. In the Strangeways' Manuscript a bifurcation of the calcified layer of the articular cartilage

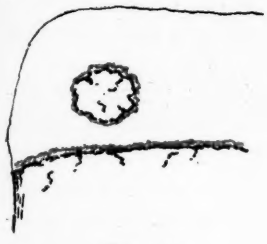

FIG. 151.

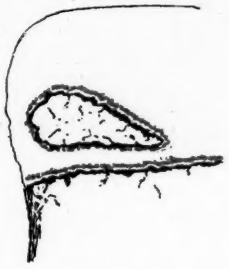

FIG. 152.

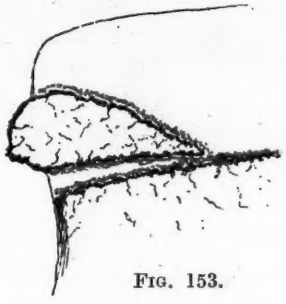

FIG. 153.

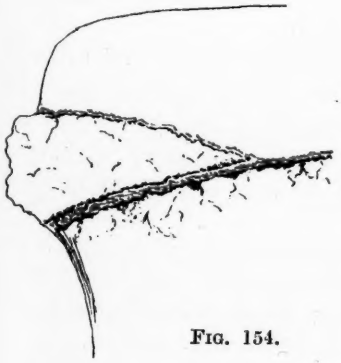

FIG. 154.

FIG. 155.

FIGS. 151–155. Diagrams to explain: (1) The bifurcation of the calcifying zone; and (2) The sequestration of pieces of cartilage (see the text). The inner black line = bone. The red line = calcified cartilage. *Fig.* 155 shows how traces of the basal line can be recognized in narrow trabeculæ showing a core of calcified cartilage; and also how a buried portion of articular cartilage (A) may arise (compare *Fig.* 153 and *Fig.* 157) and be left as an inset in an area of cancellous tissue.

at its marginal end is noted and illustrated more than once. At first sight it was not easy to understand how this duplication arose, but the examination

of a number of sections in which it appeared supplied the explanation. The manner of its development can be demonstrated best by the help of diagrams.

a. We may assume that an actively growing osteophyte forms in an articular cartilage not far from its margin. The osteophyte is surrounded by a zone of calcified cartilage, inside which is an osseous layer. The two represent the ossification zone of the growing nodule, whose cancellous structure connects with the bony layer containing it. A little distance below the osteophyte is the normal calcified layer of the articular cartilage lying upon the subchondral layer of bone. (*Fig.* 151.)

b. The osteophyte tends to grow in the direction of least resistance, and the pressure upon the articular surface helps to mould its shape, and direct it towards the margin. It assumes, often, a wedge shape, and the base of the wedge eventually projects at the side of the cartilage. Within the cartilage the osteophyte is still surrounded by its zone of chondral ossification. At this stage two calcified layers, separated by some of the deep layers of the articular cartilage, face one another—the upper one derived from the inferior surface of the osteophyte, the lower one being the marginal portion of the normal calcified zone. (*Figs.* 152, 153.)

FIG. 156.—Osteo-arthritis. An intracartilaginous osteophyte becoming marginal. From an external condyle of a femur. The bifurcation of the calcified zone is shown. A, Line of calcification above the osteophyte; B, The continuation of the normal calcified line. (*Specimen S.C.* 8.) (× 4.)

c. Advancing calcification absorbs the intervening cartilage, and the two calcified layers merge.

d. When this takes place the appearance of marginal bifurcation of the normal calcified layer is produced; the lower limb of the bifurcation is derived from the inferior surface of the osteophyte, which has blended with the end portion of the normal zone of calcification, and the upper limb is the ossifying zone of the upper surface of the osteophyte. (*Fig.* 154.) *The lower limb is consequently composed of a calcified core sandwiched between two layers of bone.** (*Fig.* 150.)

The Collection contains a section from a proximal phalangeal joint (Micro. Slide S.C. 66–1) which shows one of those rugged hypertrophies that so often deform the articular ends of the metarcarpal bones and phalanges in cases of osteo-arthritis. In the mass of new bone a calcified layer meanders in a very confusing way. The clue to its wanderings is to be found in this tendency of the calcified layer to divide and enclose an osteophyte. By tracing the calcified line in question in its bifurcations and ramifications, it is appreciated that these masses are formed by an agglomeration of osteophytes, which spring from the articular edge or the bone in its vicinity, and of secondary ones which develop from, and fuse with, those first formed.

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* See *Inflammatory and Toxic Diseases of Bone*, p. 140, and *Specimen* 810, St. Thomas's Hospital Museum.

3. Buried Islands of Articular Cartilage.—Another occasional outcome of the process just described is the sequestration of portions of articular cartilage in the cancellous tissue. An island of cartilage surrounded by an osseous border growing at its expense may be found amongst the cancellous tissue of an osteophyte, or of an articular bone-end, especially when osteophytic production runs riot upon its surface. Such an isolated piece of cartilage arises in this way. A portion of the chondro-osseous wall separating

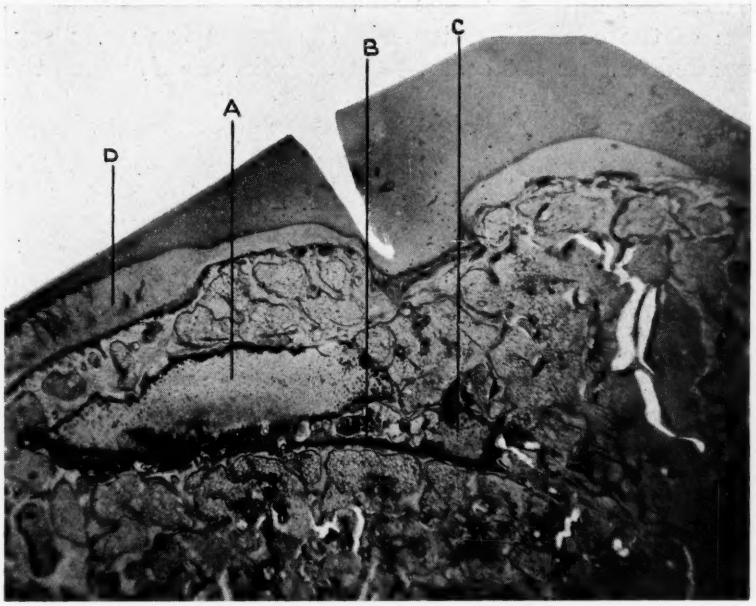

FIG. 157.—Osteo-arthritis—buried cartilage. From the posterior part of the internal condyle of the same knee from which *Figs.* 156 and 150 were taken. The surface at this point was markedly nodular. A, A buried portion of articular cartilage, ossifying on both sides, marks an inferior portion of the original cartilage; B, The original calcified layer above which a buried epiarticular osteophyte is developing and cutting off C, an isolated portion, from A; D, The superficial portion of the original articular cartilage with a calcified layer, covering the intracartilaginous osteophyte within the bounds of which the buried cartilage lies.

an osteophyte from the articular end of a bone is set free owing to resorption at its extremities. It is left *in situ*, but by the upgrowth of the cancellous tissue of the osteophyte it becomes surrounded by medullary spaces. It may be incorporated with the osseous framework in its vicinity and may lie at some depth from the articular surface. As the process of ossification continues such a submerged island must eventually disappear (*see Fig.* 155). (*Specimens* S.C. 1; S.C. 8.)

Another variety arises from the crumpling up—no doubt as the result of compression—of the articular cartilage overlying an area of extreme rarefaction. A detached portion becomes submerged. Such buried portions can be distinguished from the first form by their rugged and crushed-up appearance and the atrophic and inflammatory conditions in their vicinity. They, likewise, have a surrounding layer of bone. There are two examples in the microscopical preparations of the Collection.

B. Degenerative Changes in Sclerosed and Eburnated Bone.

Degenerative changes in eburnated bone may be studied in osteo-arthritic joints, and in those cases of rheumatoid arthritis which I have described as 'mixed'. The description of these changes may be preceded by that of some points in the histology of sclerosis, which, in the light they throw upon the changes seen in degeneration, are suggestive.

In the osteo-arthritic joint, when the articular surface retains a cartilaginous covering, sclerosis is apt to be slight, or absent, below it; and proliferation of the connective tissue in the underlying medullary spaces is either ill-marked or does not occur. On the other hand, where the cartilage

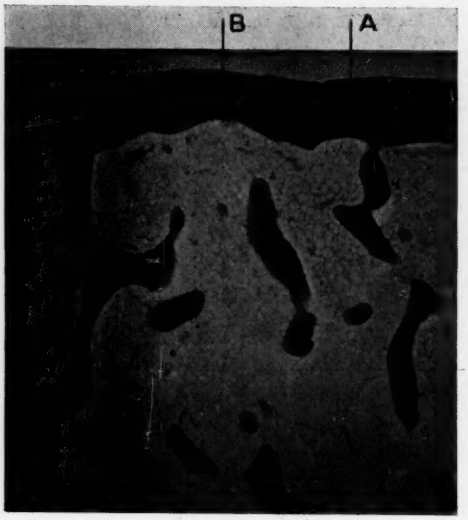

Fig. 158.—Osteo-arthritis. Section through an eburnated area of the head of the same humerus shown in *Fig.* 149. A, Thick eburnated calcified layer; B, The thin subchondroid bone layer. There is absolute quiescence at the ossification area, and the marrow is composed of fat up to the bone. (*Specimen S.C.* 15–1.) (× 16.)

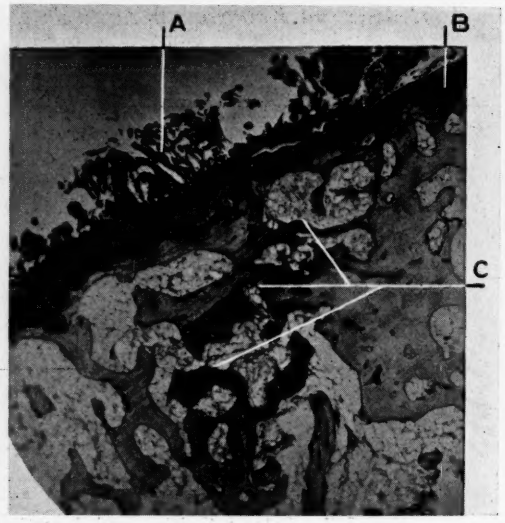

Fig. 159.—Osteo-arthritis showing degenerative changes. Section from a patella from the same case as *Figs.* 149 and 158. A, Arborescent cartilage; B, Eburnated calcified layer; C, Shaded area marking the part where active degeneration and fat formation and disintegration of sclerosed bone are in progress. There are large numbers of good-sized vessels at this part. The upper limb of C points to a part which is shown more highly magnified in *Fig.* 160. (*Specimen S.C.* 15.) (× 14.)

has been worn away, and the calcified layer or the bone exposed, the surface is dense, often sclerosed to some depth, and the proliferation of the connective tissue in the spaces contained in it and in the adjacent medullary spaces is marked. Much of the new bone which is formed in the sclerosing process is produced by metaplasia of the vascular fibrocellular connective tissue with which the spaces in the sclerosing area are filled. The method of ossification explains why some of the bony masses which form the irregular mosaic of eburnated bone sometimes contain no central canal.

Now, a solid mass of compact bone badly supplied with blood-vessels cannot be very adequately nourished; consequently, with the failure of vitality in old age or from ill health or other cause, the sclerosed bone soon

begins to show signs of degeneration. Here, a brief outline only can be given of what actually takes place.

The change begins with degeneration of small areas in the sclerosed substance. First, a group of cells becomes conspicuous in places where the bone looks granular and has lost its lamination. In a later stage a space has formed, which is filled with fibrocellular tissue; and this tissue blends with

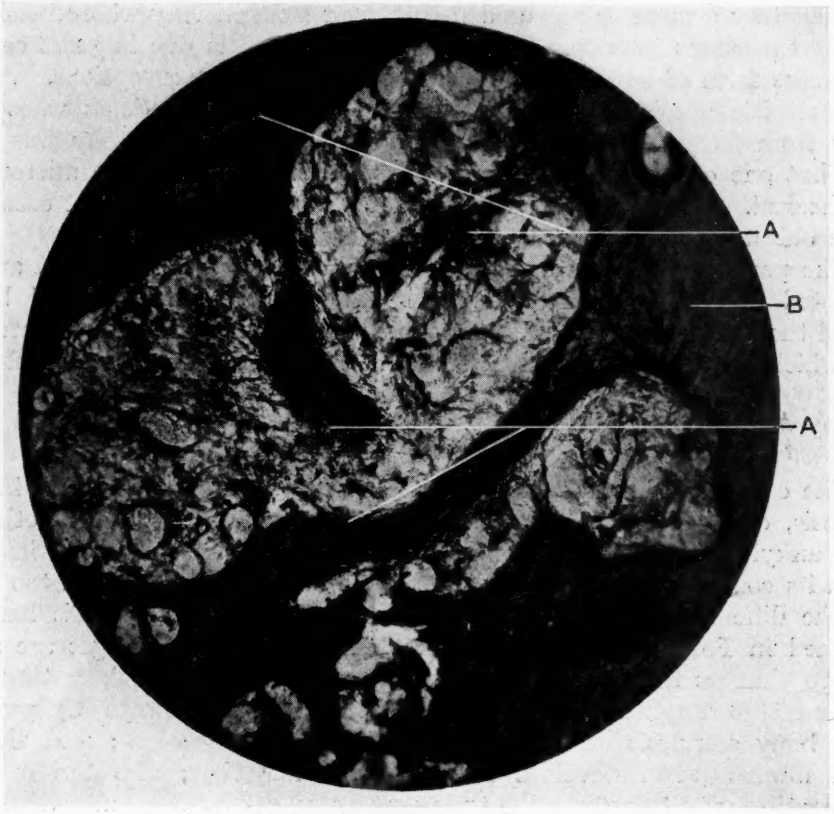

FIG. 160.—Osteo-arthritis—degeneration of bone. A more highly magnified portion of *Fig.* 159. A, Bone resolving into fibrous tissue. Contents of space, fibrous tissue, connective tissue and cells, and fat cells. B, Granular sclerotic bone, lamination lost or obscured in different parts. (× 75.)

a fibrillation which is taking place in some parts of the adjacent bone. As the sclerosed bone becomes honeycombed with such spaces, it gradually gets broken up into isolated portions, in which further progress of the resolution of the bone into fibrous tissue can usually be traced. The cellular elements of the disintegrating bone become connective tissue, forming a fibrocellular material in which the atrophying trabeculæ lie. Finally this tissue becomes fat medulla.

The eburnated articular surface of macerated bones are often seen to be marked with small 'pits' as if they had been pierced by a fairly large pin. These pits might possibly, but only for a moment, be mistaken for vascular apertures, : microscopically they are seen to be small areas, or surface clefts,

filled with fibrocellular tissue which has resulted from degeneration of the bone. The presence of these 'pits' indicates that an articular surface is entering on the degenerative stage, and that changes are beginning which, in the 'mixed cases', advance to such an extent as to graft a rheumatoid arthritic character upon an erstwhile osteo-arthritic joint.

Rarefactive atrophy, indeed, is frequently present in the hypertrophic formations of osteo-arthritic joints of elderly folks. A large marginal lip may be covered by a more or less eroded cortex enclosing a very wide-meshed and delicate cancellous interior. This atrophic condition is due in most cases to the fibrous form of bone degeneration, though there are exceptions. All the osteo-arthritic specimens in the collection came from patients whose ages varied from 63 to 83. The fibrous form of degenerative atrophy was found in all but one of the specimens in which the condition could be microscopically checked. Moreover, degeneration varied in degree in different cases, and in the oldest—a woman aged 83—it was only beginning.

The parts specially liable to degeneration were the osteophytes, and the eburnated and sclerosed areas—that is, the more recently formed bone—seemed the most prone to suffer. It will be noted that the bone selected was that which, in the main, resulted from the metaplasic process of ossification.

II. RHEUMATOID ARTHRITIS.

The category of rheumatoid arthritis comprises cases which end in bony ankylosis, cases in which fibrous ankylosis is the rule, and many others in which ankylosis never occurs, probably because the disease has not had time to run its course, or because the intensity of the disorder has been too slight.

The difference in the nature of these two forms of ankylosis has been explained in Part I; how, in the first case, articular cartilages are stimulated to changes that tend to ossification, and, in the second, cartilage and bone undergo degeneration. The cases in the Strangeways Collection in which bony ankylosis of several large joints occurs are few; but those in which fibrous union develops form a large majority; also the onset of degeneration may transform the type that ankyloses by bone into that which ends in fibrous union.

An illustration of this is provided by a knee-joint (S.C. 50–2) in which the femur and patella are united by an intervening band of tissue partly cartilaginous, but largely fibrous. In the fibrous part an osseous bond had been established between the bones, but owing to degenerative changes involving the new bone as well as the bones which it joined, bony union has been interrupted, and the new trabecula changed into fibrocellular tissue. In this case the patient was a woman in whom the disease began at 19, and death occurred at the age of 37. (*See also* S.C. 60–1.) These facts tend to show that *the pathological process which is specially to be identified with rheumatoid arthritis is degeneration — a degeneration in which both articular cartilage and bone are replaced by fibrous tissue.*

The line between progressive and degenerative change in rheumatoid arthritis is not sharply drawn and mixed conditions may be present. Thus in the very case from which the changes leading up to bony ankylosis were

described, there are also some signs of degeneration in both the cartilage and the bone (S.C. 27). It will be remembered that in that case only two joints out of the eight included in the Collection were not the subject of bony ankylosis. When the patient died at the age of 54 those two joints were hovering between tissue growth and tissue degeneration. Had she lived much longer, it is not unlikely that the latter process would have gained the upper hand, and the degenerative form of rheumatoid arthritis and fibrous ankylosis have resulted.

Sometimes one joint does become ankylosed by bone and another by fibrous tissue; for instance, in a woman of 71, the right knee was fixed by bony union, and the left was the subject of fibrous ankylosis. Fibrous degeneration of the articular bone was so pronounced in the latter joint that

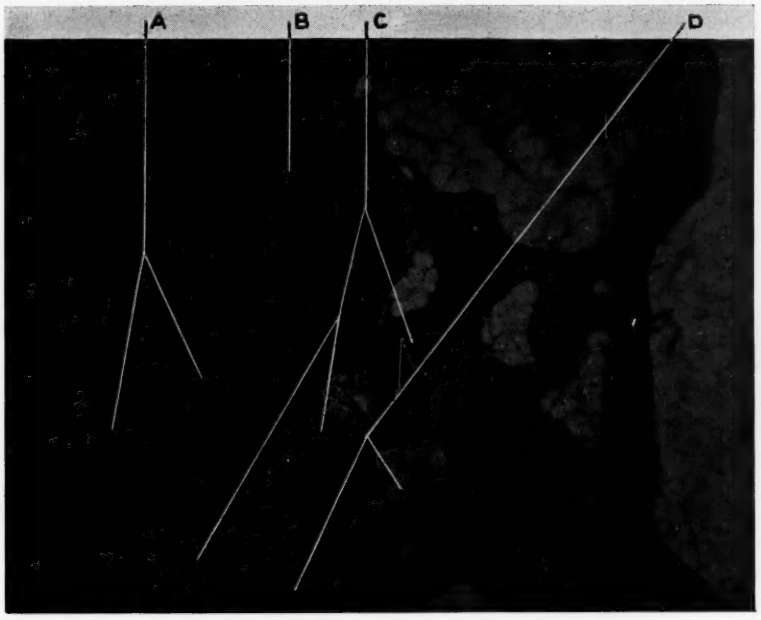

FIG. 161.—Rheumatoid arthritis. Section from the posterior part of the same condyle as that shown in *Fig.* 162. It shows the pronounced changes so commonly seen in rheumatoid arthritis at the junction of the cartilage and bone, and how both calcified cartilage and bone tend to degenerate into fibrous tissue. A, Zone of calcified cartilage; B, Fibrocartilage lying on bone, apparently replacing the calcified cartilage; C, Bone trabeculæ undergoing fibrous resolution at their margins. D, Spaces filled with fibrocellular tissue—no inflammatory cells. (× 50.)

no bony union would have been possible. (S.C. 26; S.C. 26–1.) Such a case may point to unequal powers of resistance in the two joints or to a failure of general joint vitality after bony ankylosis has already occurred in one.

It has been shown that fibrous degeneration of cartilage and bone is not a purely senile change (Part I, pp. 128, 129). Nor is it peculiar to the rheumatoid affections, for it was present in a chronic septic knee amputated at a war hospital in England. But it is found in all forms of chronic rheumatoid disease.

In osteo-arthritis it is present in many cases well advanced in years (*see* p. 316). In rheumatoid arthritis the bony ankylosing type may, in its later stages, show signs of it; whilst in the cases that end in fibrous ankylosis, fibrous degeneration of bone and cartilage is the outstanding histological feature and may or may not be associated with marked signs of inflammation.

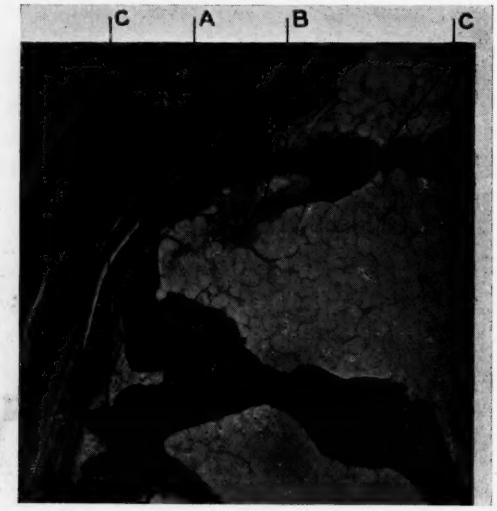

FIG. 162.—Rheumatoid arthritis. Section from the anterior part of the internal condyle of the left knee of a woman aged 76. It shows the fibroid degeneration of the articular surface structures. A, Fibrous covering—partly transformed cartilage, partly resolved bone; B, Fibrous strands representing resolved bone; C, Resolving parts of edges of trabeculæ. (*Specimen S.C.* 41–5.) (× 50.)

In a further contribution (Part III) I shall show that the same form of degeneration is an important factor in the joint changes in Charcot's disease. (*See also Fig.* 41, p. 117, Part I.)

THE HISTOLOGY OF FIBROUS DEGENERATION OF CARTILAGE AND BONE.

The form of degeneration taken by cartilage and bone in rheumatoid arthritis calls for a more detailed description than the fragmentary outline already given (p. 315). The histology is not simple and appearances are apt to be confusing. Some are very like changes seen in ossification, and it may not always be easy to decide whether they point to a stage in an atypical production of bone or to its degeneration. Indeed, often only by an appreciation of surrounding conditions can an observer be sure that he is looking at resolving and not growing bone, or that a space is a consequence of degeneration, and not a primitive medullary space engaged in preparing the way for ossification.

1. **The Formation of Spaces in Bone.**—The changes occurring in fibrous degeneration of bone may be studied in their initial stages in the central parts of a large trabecula or in a mass of sclerosed bone.

The first indication is a localized crowding of cells, and a granular

obscuration of the bone structure. The crowded cells are certainly not all bone-cells. Delicate fibres may sometimes be seen amongst them, and adjacent bone-cell cavities may appear too large for the cells they contain.

The next stage is the appearance of a space filled with the cells supported in a mesh-work of fine fibrous tissue. The cells are now connective-tissue cells, fusiform, stellate, or angular; and, rarely, a bone-cell, which possibly has escaped modification, may be recognized. The bony margins of the space may show at some part a blurring, in which it is possible to focus numerous fine fibrils issuing from the bone. These fibrils are lost in the fibrocellular contents of the space. In a sclerosed mass there may be several

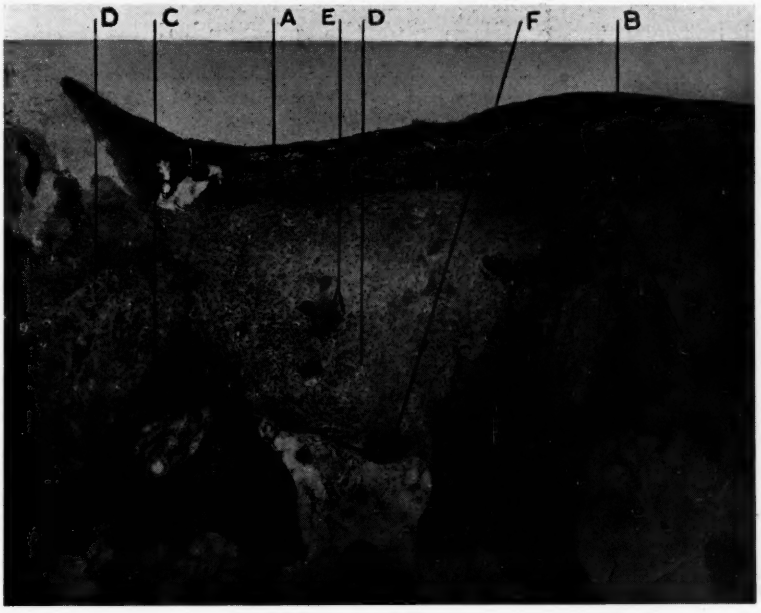

FIG. 163.—Rheumatoid arthritis. Section from the articular surface of the tibia from the same knee as *Figs.* 161 and 162. It shows destruction of the calcified cartilage and subchondral bone. A, Degenerating articular cartilage, superficial part; B, Zone of calcified cartilage; C, Trabeculæ undergoing resolution into fibrous tissue at their edges; D, Thick layer of proliferated fibro-connective tissue containing disappearing portions of calcified cartilage; E, Giant cells; F, A trabecula almost completely resolved into fibrous tissue. (× 50.)

cellular foci or spaces of this nature, and other larger spaces with similar contents have clearly resulted from the confluence of several small ones. The subchondral layer of bone is a favourite situation for these spaces, and in some joints they may form quite a long row in it without trenching upon the calcified layer. (S.C. 49 from Kathleen M., age 16, is an instance.) Frequently, however, that layer, which is particularly prone to suffer in this form of degeneration, is also involved. Giant cells are very often a conspicuous feature in these spaces, and appear at an early stage in their development. They no doubt play an important part in their formation and enlargement (*see* p. 323).

2. Fibrous Resolution of Bone.—In addition to the formation of spaces,

the margins of trabeculæ are affected, and especially portions of the subchondral bone layer. The degenerative process is indicated by the thinning and often granular appearance of the bone, by an increase in prominence and number of the bone-cell cavities and their contained cells, and by an emergence of crowded fibrils to join the fibro-connective-tissue contents of the medullary spaces, in whose bordering trabeculæ this change is going on. Often bands of fibrous tissue, representing portions of vanished bone, may be seen bridging an interruption of the subchondral layer, linking up neighbouring trabeculæ or forming a portion of the peripheral laminæ of others. The bone in the vicinity of these fibrous joinings usually shows signs of degenerative change. (*Fig.* 162.)

Again, a thin layer—more cellular than fibrous—is not infrequently interposed between the cartilage and the subchondral layer of bone, and

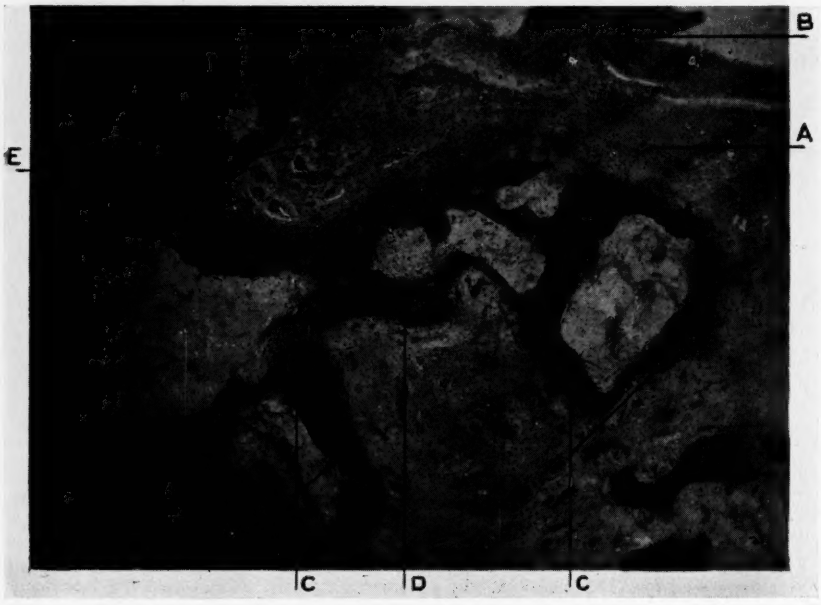

FIG. 164.—Rheumatoid arthritis. Section from the articular surface of the head of the radius (right elbow) from the same patient as *Figs.* 161 to 163. It shows the fibrous degeneration of bone and cartilage at the articular surface. A, Fibrous covering made up of transformed cartilage and resolved bone; B, Fibrous villus on the surface; C, Trabeculæ undergoing fibrous resolution; D, Degeneration in the body of a trabecula; E, Vessels—inflammatory cells. (*Specimen S.C.* 41–7.) (× 50.)

contrasts strongly with both. The margin of the bone on which the layer rests is eroded, as if it had been nibbled by a mouse, an appearance which is produced by the opening up of the bone-cell spaces. In some places traces of degeneration are present in the interior of the bone. I have no doubt that this fibrocellular layer originates from the decaying bony articular surface.

Resolution of bone into fibrous tissue may not only extend along the subchondral layer, but may involve the deeper trabeculæ in places, causing more or less destruction. Indeed, in some cases large tracts or masses of

fibrous tissue occupy the place of a number of trabeculæ, to whose previous existence small portions of resolving bone bear witness.

3. **Fibrous Resolution of Cartilage.**—In the cartilage very similar changes give rise to spaces filled with fibro-connective-tissue of the type already described. Frequently portions of cartilage, either lying isolated within these spaces or forming a portion of their walls, may be seen giving off a wisp of fibres which blend eventually with the contents of the space.

There is no danger of confusing the above changes with *the fibrous transformation of the articular cartilage* which is so often seen in rheumatoid arthritis.

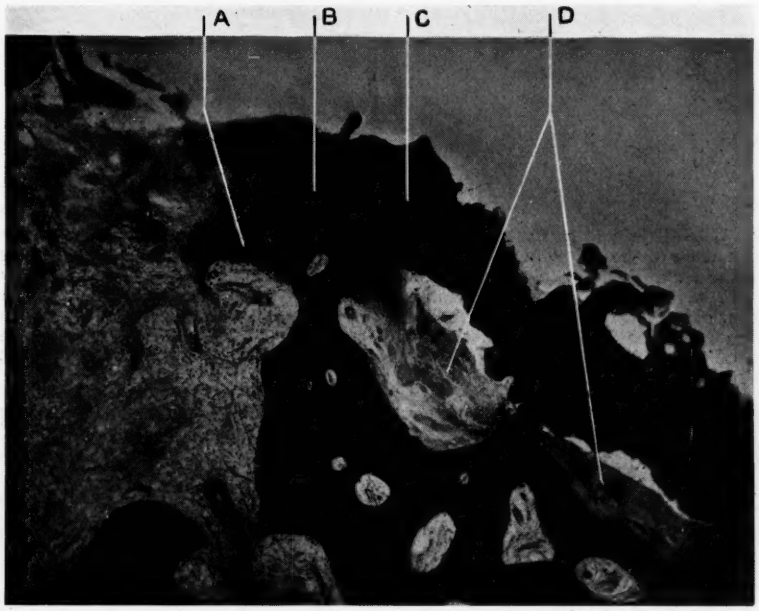

FIG. 165.—Rheumatoid arthritis. Section showing the articular surface of the ulna, from the same elbow as *Fig.* 164. A, Part of a trabecula resolving into fibrous tissue at its margin; B, A portion of degenerate subchondroid bone layer giving off fibrous tissue at both ends: C, Degenerating cartilage—spaces contain proliferated connective tissue; D, Spaces resulting from degeneration of large portions of the subchondral bone layer and adjacent cartilage, containing fibrous tissue, connective-tissue cells, vessels, and fading relics of bone tissue. At a few points on their margins the bone is giving off fine fibrous tissue. (*Specimen S.C.* 41–7.) (× 50.)

The latter usually starts at the surface as fine horizontal fibres in the substance of the cartilage, and goes on to fibrous replacement of the superficial layers. It may even involve the whole depth of the cartilage without disguising its identity. It is not necessary for it to be accompanied by the degenerative signs I am describing, but the two forms of fibrous change are often seen together.

Any difficulty in deciding as to the true character of the changes which have been specified will usually disappear upon a comprehensive review of the section. As a rule it is evident that bone and cartilage are steadily disappearing: their distinctive characters are being lost, and they are in process of being replaced by fibrous tissue, which is sometimes very cellular

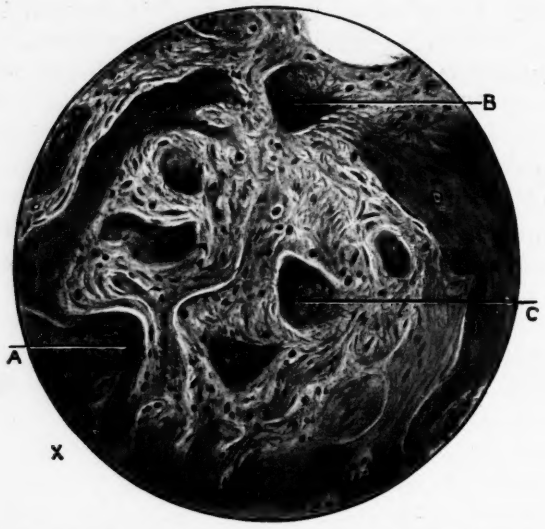

FIG. 166.—Origin of a giant cell in bone substance. Drawing from a section from the articular surface of the femur in a septic knee-joint, obtained from a war hospital in England, showing the formation of a giant cell in bone or possibly calcified cartilage. A, Giant cell forming in a projection of the subchondroid bone layer or the adjacent calcified zone; B, Another giant cell whose position and the appearance of surrounding parts suggest recent separation from the bone; C, Another with resolving bone attached; X indicates the position of the articular cartilage outside the picture. (*Specimen* S.C. 99.) (× 235.)

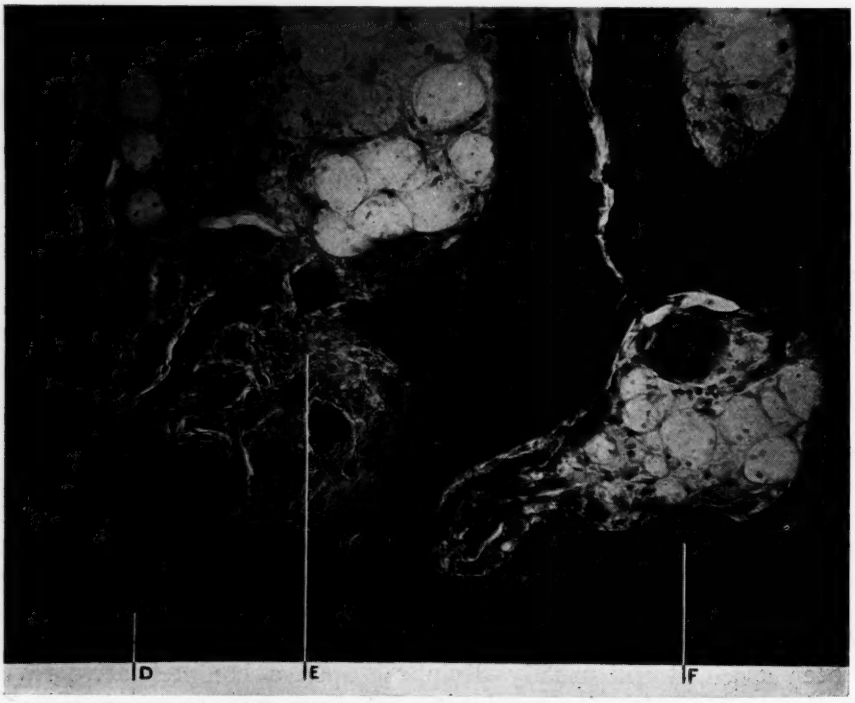

FIG. 167.—Photomicrograph from a section from the articular surface of the femur in a septic knee-joint, obtained from a war hospital in England, showing the formation of a giant cell in calcified cartilage or possibly bone. D, Articular cartilage; E, Portion shown in *Fig.* 166; F, Subchondral bone layer. (*Specimen S.C.* 99.) (× 120.)

and sometimes only slightly so. The changes are most marked in the immediate neighbourhood of the cartilaginous junction, and in many cases quite long tracts of the calcified layer, with adjacent portions of the cartilage and the subchondral bone layer, have vanished.

The Origin of Giant Cells associated with Bone. —An important histological feature of these rheumatoid cases is the frequency with which giant cells, often in considerable numbers, are found in the degenerating areas. They excited no particular interest until one was found among an aggregation of cells which heralded the formation of a space. It was then realized that they were often present in the smaller recently formed spaces. Four or five were not uncommon, and in a space formed by the coalescence of several small ones more than twenty were counted. Further, it was found that a giant cell was present in a potential space more commonly than had been suspected, and the idea that they might prove to be formed from cells within the substance of bone or cartilage occurred to me. The suspicion was confirmed by a section cut from the femoral condyle of the chronic septic joint (S.C. 99) already mentioned. In this slide two spaces bearing the usual signs of fibrous degeneration of bone are present in the subchondral layer beneath a strip of cartilage, which at this part has not been seriously affected by the inflammatory process. On the margin of one of the spaces is a nipple-like projection, and in its interior are some twenty or thirty nuclei crowded together. At first taken for a giant cell, it was soon seen to be part of the bone or calcified layer, which at this point are not readily distinguishable from one another. On the deep attached side of this projection disintegrating changes are just beginning to take place and the multinucleated mass would no doubt eventually become detached. There are six other giant cells in the space ; one has evidently just separated from another part of the margin, and another blends with a granular mass as big as itself, whose fibrous interior and emanations point to its being a resolving fragment of bone.*

Evidently in the fibrous degeneration which occurs in rheumatoid arthritis the disintegration of bone and cartilage is materially helped by the development of giant cells in their substance, and the solution of the matrix surrounding them ; whilst the formation of such cells in the bone or cartilage substance, and their subsequent separation, will cause a form of crumbling away of tissue not hitherto envisaged.

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* The following observations by Professor M. J. Stewart are of interest in connection with this matter :—

" The bone consists in the first place of osseous tissue proper, which includes bone cells, calcified matrix, osteoblasts, and osteoclasts. These are enclosed in a sheath of fibrous tissue, the most obvious and complete portion of which is periosteum. The inner aspect of the bone, however, is also covered by a thinner and more delicate layer of fibrous tissue—the endosteum—which not merely lines the main medullary cavity itself, but clothes all the little bony lamellæ of the cancellous tissue . . . my own histological observations have assured me that the osteoclast is met with only in relation to bone, and that it does not occur throughout the marrow generally. Its normal position is within the bony tissue or at least between the bone and its peri- or endosteum."

" Histogenesis of Myeloid Sarcoma ", *Lancet*, 1922, ii, 1906.

Specific Forms of Rheumatoid Arthritis.

The Collection contains a group of specimens obtained from cases which were infected with some specific disease. These cases were marked by an illness of many years' duration, by painful chronic swellings of numerous joints, and by a crippled and bed-ridden condition, which terminated in death from exhaustion. In their clinical course they resembled, and were looked upon as, rheumatoid arthritis; but one was subsequently proved to be due to pneumococcal infection; another is suspected to have been syphilitic (congenital) because of a general endo-arteritis affecting the synovial vessels; and of two others, one was due to the gonococcus, and in the second the gonococcus was probably closely associated with the latter part of its course. Fibrous degeneration of bone, like that seen in rheumatoid arthritis, was found in all of them.

The clinical course and histology justify these cases being regarded as rheumatoid arthritis due to a specific cause—an infection. The type is quite distinct from the well-recognized joint conditions commonly attributed to such infections; and the specific rheumatoid form may easily be distinguished by the use of the suitable adjective, e.g., pneumococcal, syphilitic, gonorrhœal, rheumatoid arthritis. There would be much advantage in such a nomenclature, for since these cases are usually considered to be rheumatoid arthritis during life, a correct diagnosis is more likely to be made, if it is taught and appreciated that such specific types occur.

Case 7.—**Pneumococcal rheumatoid arthritis.** (*Specimens S.C.* 57 *Group.*)

John S., a carman, age 31. Some years before death joint trouble began gradually with swelling and a little pain in the right knee. These increased and he was laid up for thirteen weeks. Then the swelling subsided, and he worked for two years. In 1906 the right knee again became swollen, and he was laid up for three months. In 1907 both knees became swollen and painful, and he never worked again. In 1908 he contracted gonorrhœa, which cleared up without apparently affecting any joint. In December he had iritis, and though he was bedridden the right ankle became swollen and painful. In November, 1909, he entered St. Pancras Infirmary. Both knees were swollen and contained fluid. Temperature and urine were normal. During 1910 he was more or less in bed with recurring trouble in knees, ankles, and joints of the upper extremities. In 1911 Dr. Strangeways saw him and noted that he was a "case of apparently typical rheumatoid arthritis with great deformity and pain in the joints and limbs. There were spindle-shaped swellings of the phalangeal joints." Further attacks of arthritis occurred in September, followed by iritis, and then more arthritis. In January to April, 1912, there was more iritis, and the left eye was excised. In July he became worse with right-sided pleurisy, and died.

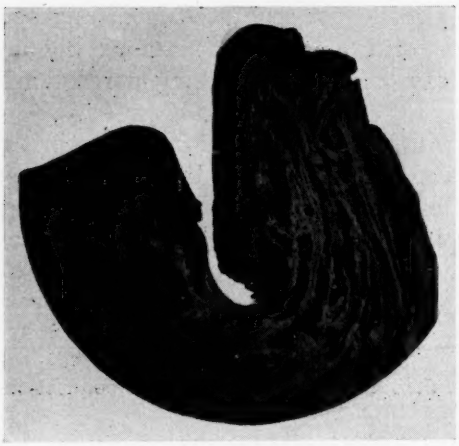

Fig. 168.—Pneumococcal rheumatoid arthritis. Section through a portion of the capsule of the right shoulder. Showing a villous process and leucocytic infiltration: from a man aged 31. (*Specimen S.C.* 57.) (× 25.)

POST MORTEM.—Turbid greenish pus with a foul odour was found in both shoulders and both elbows. A pure culture of a Gram-positive diplococcus was obtained from the pus, and reproduced after animal inoculation. This was authoritatively stated to be undoubtedly pneumococcal. A Gram-positive diplococcus was also demonstrated in sections from the capsule of the knee—at the College of Surgeons.

MICROSCOPICAL EXAMINATION.—Examination of slides from the shoulder and elbow showed marked evidence of inflammation and destruction of tissue in the peripheral part of the articular surface. The destruction involved the deep portion of the articular cartilage, the calcified zone, and the subchondral layer, and was due

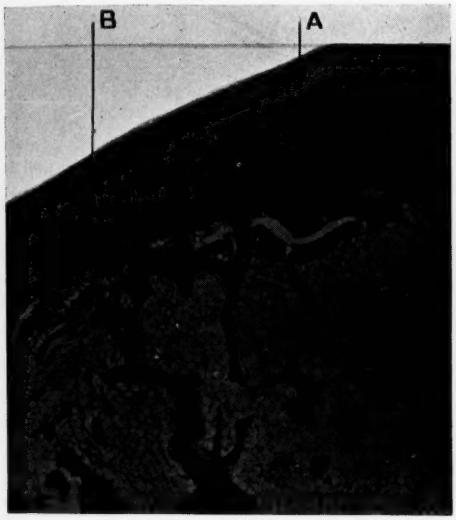

FIG. 169.—Pneumococcal rheumatoid arthritis. Section from the head of the right humerus from the same patient as *Fig.* 168, showing degeneration and destruction of the subchondroid bone layer and the zone of calcification beneath practically normal cartilage. A, Degenerating spaces in the subchondral bone layer; B, At peripheral part of the articular surface the calcified layer, parts of the deep layer of the cartilage, and portions of the subchondral bone layer have disappeared. (× 14.)

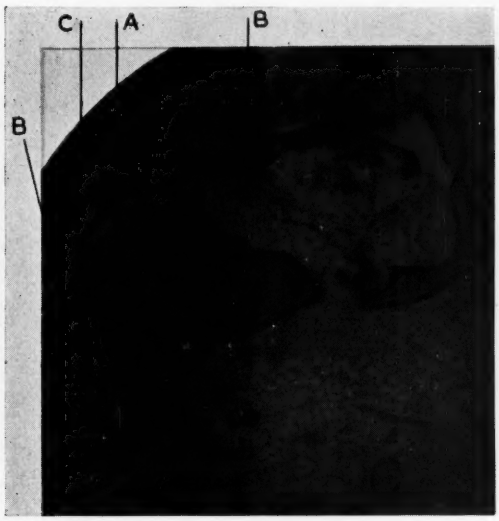

FIG. 170.—Pneumococcal rheumatoid arthritis. From the same section as *Fig.* 169 (humerus), but nearer the articular margin. It shows the inflammatory tissue in the medulla, granulation tissue, vessels, fibrous tissue, diffuse inflammatory cell infiltration, also the disappearance of the subchondral bone layer. A, Bone degenerating and resolving into fibrous tissue; B, Granulation tissue; C, Articular cartilage. (× 40.)

to the degeneration of bone and cartilage into fibrocellular tissue. Characteristic degenerative spaces were present in central parts of the trabeculæ of the subchondral bone layer and there was abundant evidence of fibrous resolution of bone. The adjacent periosteum was inflamed.

(T. S. P. Strangeways, *Bulletin Camb. Com. for the Study of Special Diseases*, iv, No. 6, 87.)

The possibility that in this case the pneumococcal infection was superimposed on rheumatoid arthritis has to be taken into account.

Case 8.—**Syphilitic (congenital) rheumatoid arthritis.**

A young man, age 22, had his right knee-joint excised by Mr. Wherry in Addenbrooke's Hospital, Cambridge, for a condition thought to be tuberculous. There was a history of two years' pain, swelling, and resistance to treatment. He made an uneventful recovery from the operation, but after leaving the hospital all his joints became affected, and in due course he was completely crippled. There was pain, swelling, and stiffness especially in the hips, left knee, ankles, and hands, and he could not turn in bed. His shoulders were less involved. The hands were deformed.

There were no discharging sinuses connected with the joints. At the age of 33 he developed pneumonia, and not long after died from exhaustion caused by bed-sores.

A sister is stated to have suffered for about forty years from tuberculous disease of both feet. The right foot was amputated in 1913; and the left, which had discharging sinuses, in 1916. No attempt was made to substantiate the diagnosis at the time (personal communication).

The specimen (S.C. 58), which consists of the parts removed by excision, is remarkable for the great thickening of the synovial membrane, and its villous projections, which have a lumpy tuberous form. Microscopically there is no evidence of tubercle,

FIG. 171.—Syphilitic rheumatoid arthritis. Section of chronically inflamed synovial membrane from a knee-joint of *Case* 8, showing endo-arteritis of vessels. (*Specimen* S.C. 58.) (× 40.)

but the blood-vessels of the synovial membrane are remarkable. They are very numerous, and the subject of chronic endo-arteritis, which has obliterated the lumen of many. The peculiar condition of the blood-vessels is believed to point definitely to the syphilitic nature of the disease. There are pronounced changes in the trabeculæ, and in parts of the articular cartilage of the femur. The subarticular bone is generally involved, and where the cartilage has disappeared the destruction is marked. Resolution into fibrous tissue, and degenerative spaces, occur. In many places the former is very beautifully shown, both in the cortex of the side of the condyle beneath the thickened capsule, and in the part referred to above where the cartilage is absent. This form of degeneration is less noticeable in the patella, where atrophy of the cancellous tissue is pronounced.

Search was made for spirochætes and tubercle bacilli in the synovial membrane taken from the specimen, but neither were found. (R.C.S.)

Case 9.—**Gonorrhœal rheumatoid arthritis.**

W. A., a wood turner, who was 48 years old when he died, contracted gonorrhœa at 19, had rheumatic fever at 21, and again when he was 29 in 1903. Subsequently he was subject to pains all over, but particularly down his spine. In 1906 the right shoulder and elbow became increasingly stiff, and later the left shoulder and elbow were attacked. In 1908 the spine was involved, and in 1909 the jaw. In this year he had to give up working. The right knee (S.C. 61) became swollen in 1910. The patient became very emaciated and his weight fell to 6 st. 9 lb. There was much muscular wasting, diagnosed as progressive muscular atrophy, but there were "none of the characteristic changes associated with osteo-arthritis." He died from bronchitis in 1911.

Post Mortem.—The knees, hips, and elbows were flexed, and movement was only possible through an extremely limited range. The ankles, shoulders, and wrists were in a similar condition. The hands were contracted, and the small muscles, like the general musculature, were in a condition of advanced atrophy. Gonococci were found in a portion of the capsule taken from the specimen (R.C.S.). Microscopically, a section from the femoral condyle shows pronounced signs of degeneration in the form of fibrous resolution. This occurs in the neighbourhood of a sharp-edged marginal ulceration of the articular surface. The floor of the ulcer is formed by granulation tissue which penetrates amongst the cancelli below. A similar, but a small, area of degeneration is seen at some distance from the margin, where an erosion of the cartilage has exposed the subarticular bone. Besides this there are a few characteristic degenerative spaces with fibrous margins distributed in the cartilage and in the subchondral bone layer. (*Fig.* 172.)

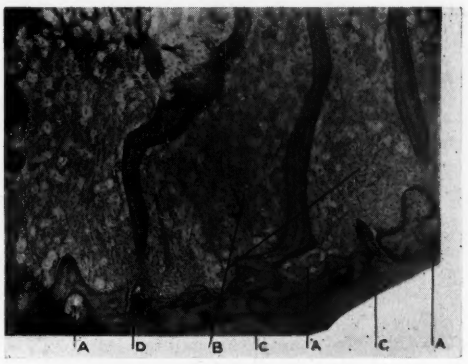

Fig. 172.—Gonorrhœal rheumatoid arthritis; part of the articular surface of the internal condyle from the knee-joint of *Case* 9. A, Spaces resulting from bone degeneration, with fibrocellular contents, giant cells, and degenerating margins: B, Granulation tissue; C, Surface fibrous covering, largely the result of cartilage degeneration; D, A collection of inflammatory cells. Fibrous resolution of bone is to be seen in places. (*Specimen* S.C. 61.) (× 25.)

A peculiar appearance of the fat marrow is present in this case. The fat cells have a protoplasmic mass of variable size situated at some part of their periphery. The fat cells themselves are not as a rule in contact, but are surrounded by a clear ring-like space, and occasionally the retiform connective tissue can be seen to have its spaces distended. These appearances point to fat absorption; the pressure of the œdematous fluid, whose presence can be explained by the inflamed state of the medulla, may be an auxiliary factor. (*Fig.* 173.)

A similar condition was met with in two other cases (S.C. 31, S.C. 55) where emaciation was advanced, but in many others apparently equally wasted the fat marrow was natural.

Case 10.—**Gonorrhœal rheumatoid arthritis.**

A man who was 38 when he died in 1912 had an illness, diagnosed as 'gastric fever', in 1887. At the age of 19 (1893) he was ill for fifteen weeks with severe rheumatic fever. At 21 (1895) he contracted gonorrhœa, which lasted three months and cleared up. In 1898 he was ill for eight months with rheumatism in the hips and knees. From this he recovered, but in 1903 he developed acute pain in the left knee and hips, and was two months in University College Hospital. In 1912—the year of his death—he had been bedridden for years. The hands were much distorted, the spine was ankylosed and curved, and the movements of all the joints were greatly limited.

Doubtful gonococci were found in the capsule of the knee-joint (S.C. 60). The cocci were Gram-negative; in places they were diplococci; some were intracellular, but their shape was not distinctive (R.C.S.). Microscopically, degeneration of cartilage and bone into fibrocellular tissue, like that seen in rheumatoid arthritis, is present. There is, also, much inflammation. In the fibrous union of the patella to the femur there are signs of an attempt at bony ankylosis, which had been frustrated by extensive degeneration of the bone and cartilage.

FIG. 173.—Gonorrhœal rheumatoid arthritis. From the same section of the internal condyle as *Fig.* 172. To show the œdematous fat medulla; the fat globules undergoing absorption. (× 200.)

In this instance the fibrous form of ankylosis developed in a man who had shown rheumatic tendencies before he contracted gonorrhœa. The picture may be completed by reference to a case that I have recorded in which generalized bony ankylosis followed gonorrhœa in a gentleman, age 37, who some time before he contracted gonorrhœa had suffered from pleuritic effusion, and had developed effusion into both knees whilst convalescing from this illness. (*The Inflammatory and Toxic Diseases of Bone*, p. 182, Case 5.)

SCHULLER'S VILLOUS ARTHRITIS.

Case 11.—This case is placed after those illustrating specific forms of rheumatoid arthritis because there is not sufficient justification for including it in that group. Though little more than a fragment, it is recorded here because, clinically, it seems to belong to the rheumatoid arthritis category, and as similar cases are uncommon it may be useful as well as interesting. There is only one specimen of this condition in the Collection (S.C. 53). Unfortunately it comprises only a few of the villous processes; and the termination of the case could not be traced. The exhibit consists of several more or less pedunculated, soft, lobulated masses resembling in appearance portions of parotid gland.

Microscopical Examination.—A slightly magnified section of one of the masses is reminiscent of a rectal polypus in the arrangement of its lobules. Under the usual powers the interior presents an anastomosing framework of fibrous tissue forming numerous spaces, in which are sections of vessels and a reticular stroma supporting connective-tissue cells more or less crowded. These cells have large nuclei and a narrow cell-substance, and some larger ones have more than one nucleus.

In some lobules the cells are pressed together and have a polyangular shape, whilst the fibrous framework is more defined. The containing border of a lobule is formed by a layer of rather dense fibrous tissue, in which are oval cells of considerable size with large pale-staining nuclei. Situated in the cellular parts of the interior are a few isolated areas of crowded inflammatory cells; they contain no giant cells. Amongst some of them are narrow tracts of cells with large nuclei, not so deeply stained as the inflammatory cells, or as the connective-tissue cells of the parenchyma. They are possibly endothelial cells—derived from vessels, lymphatic or otherwise. A striking feature is the great number of vessels in cross-section, each occupying a central portion in a space. These, and the scattered fat cells, and the loose arrangement of the parenchymatous cells, give the impression of a somewhat open texture. No tubercle bacilli were found in a recent examination, and no other organisms were noted.

Clinical History.—The patient was a motor-lorry driver, and was consequently much exposed to wet and cold in his occupation, but he was always fit and hard like other men. He worked from fifteen to twenty hours a day (*sic*), used to weigh

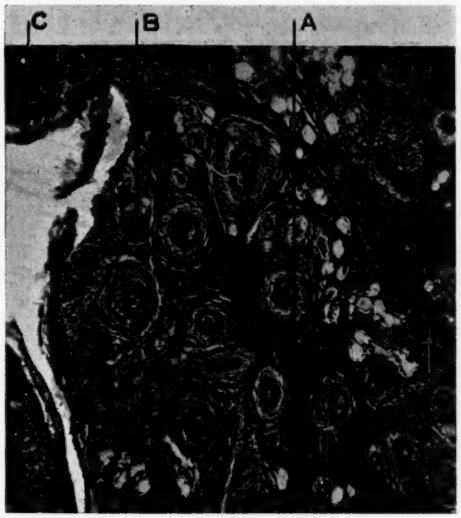

Fig. 174.—Schuller's villous arthritis. Section through a polypoid villus. A, Fibrous framework; B. Connective-tissue cells; C, Inflammatory cell groups. (*Specimen* S.C. 53.) (× 50.)

13 stone, but had lost flesh since his illness began. He looked pale, but never felt ill or depressed. The first sign of trouble began in July, 1921, when a gradually increasing stiffness in the left arm came on when he was driving. There had been

no previous injury. Swelling of the knee followed in August and slowly increased. In two or three months it reached the size that persisted whilst he was under observation. Pain at first was slight and he was just able to get about. It got worse, but was never severe, and after a few months he was admitted to the London Hospital. There was a similar history for the right knee. The left ankle became affected in November, and the left elbow about the same time. One wrist followed in March, 1922, and the right shoulder towards the end of the year. In Marylebone Hospital "the right knee was aspirated on two occasions. No organism was ever obtained on culture of the fluid." A radiogram showed "no bony changes, approximation of joint lines, and thickening and swelling of the soft structures of the joint." "On June 9, 1922, a small portion of villous growth was removed at operation" (arthrotomy). "Mr. Strangeways diagnosed Schuller's villous arthritis. At that time the patient had tubercle bacilli present in the sputum on many occasions, and the (lung) disease was fairly extensive." He was re-admitted on Sept. 12, 1923, with his joints not materially altered, and was transferred to West Ham Hospital in February, 1924. It is impossible to ascertain his history beyond this point, but "in view of the lung condition in 1922 it is improbable that he is still alive."*

Max Schuller, who first described the condition, and found cocci and bacilli in the villous processes, calls it "inflammatory hyperplasia of the normal synovial processes as they occur in chronically inflamed synovial membranes" (*Arch. f. klin. Chir.*, 1893, xlv, 153). His illustrations of the histology are very similar to the photograph from the section from this specimen. The microscopical picture is very different from that presented by the synovial villi so frequently seen in rheumatoid joints (*see Figs.* 159, 168). It is possible that the condition was caused by irritation of tuberculous toxins. There was no certain microscopical evidence of tubercle in the section examined,† nor could the affection be regarded as any recognized form of tuberculous disease of the joints. On the other hand, the involvement of a number of joints within a reasonable period shows a close resemblance to rheumatoid arthritis.

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* I am indebted to Dr. Basil Hood for the later history of this case.

† This statement is made with a little hesitation. The slides were submitted to an experienced pathologist who decided unhesitatingly against tubercle. The narrow tracts of (? endothelioid) cells occurring in the scattered masses of inflammatory cells must not be overlooked. Watson Cheyne considers endothelioid cells scattered irregularly or running in broad tracts through inflammatory tissue to be one of the two characteristic forms of tuberculous inflammation. Bacilli are found in and amongst them. (*Inflammatory and Toxic Diseases of Bone*, p. 57.) The tracts in the section were carefully searched for bacilli, and in vain (R. C. S.).

(*To be continued.*)

TUBERCULOUS HYPERPLASIA OF THE LARGE INTESTINE (HUMAN TUBERCLE BACILLUS).

A REPORT OF A CASE WITH UNUSUAL FEATURES.

By JOHN ANDERSON,
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AND W. T. MUNRO,
MEDICAL SUPERINTENDENT, GLENLOMOND SANATORIUM.

In the March number of the *Edinburgh Medical Journal*, 1931, we gave an account of this interesting condition (*Fig.* 175). We discussed at some length the pathology of the condition, reviewed the symptomatology and diagnosis, and were able to determine the type of tubercle bacillus, whether human or bovine, in the more recent cases coming under our observation. Since that paper was written another case worthy of comment has come under our care. The first point of interest in this case is that an elder sister was operated on in the Edinburgh Royal Infirmary for a similar although much less extensive lesion. In searching through the literature, and reviewing the histories of all the published cases which we could obtain, we have failed to find any instance of familial disease of this nature. Possibly this is not surprising when the comparative infrequency of the condition is considered. In all the previous cases in which we have been able to isolate the infecting virus a bovine type tubercle bacillus has been found; and the bovine type is less likely to be responsible for familial disease.

Pulmonary tuberculosis due to the human type bacillus is notoriously a familial disease, but no familial instance of two cases of pulmonary tuberculosis due to the bovine type has come to our knowledge. Possibly some explanation of the familial incidence in this case can be given when it is said at once that the virus in this case was proved to be a human type tubercle bacillus; but why should the disease appear in the two sisters as a tuberculous hyperplasia of bowel?

CASE REPORTS.

A brief account will be given of *Case* 1. We are much indebted to Mr. D. P. D. Wilkie, Professor of Surgery, Edinburgh, who has allowed us to make full use of the clinical report from his wards.

Case 1.—S. W., female, age 14 years, admitted on Nov. 11, 1925. Complaint—pain and borborygmi over the abdomen for five years, and latterly pain and some vomiting. Previous history, tuberculous glands excised from the neck in 1914. Patient was then 3 years of age, and this operation was done in the Cottage Hospital, Dunfermline; when seen in November, 1925, patient was thin, abdomen showed no peristalsis, but examination by barium meal showed retention of the meal in the lower ileum. Laparotomy—the lower six inches of the ileum were hypertrophied

and were resected and an end-to-end anastomosis was made. The histological examination showed the condition to be tuberculous. The patient made a perfect recovery. She is now in domestic service in Kinross and is very fit.

Case 2.—J. W., female, age 16 years. Glenlomond and Royal Infirmary, Dundee. The patient was in Glenlomond Sanatorium from December, 1928, to June, 1929. She then showed small glands in the neck and had complained of pain in the abdomen. Nothing much was noted on examination of the abdomen and

FIG. 175.—Hyperplasia of the large intestine. Bowel from ileum to splenic flexure. Note rugose formation of epithelium and thickness of gut on cross-section.

she went home apparently well. She remained well till January, 1931, when she began to complain of pain in the abdomen, some constipation or diarrhœa, at times vomiting, and loss of weight. Her attacks of pain had been constant to the right side of the abdomen about the level of the umbilicus. On admission she was very thin and her colour was poor with rather an earthy tinge. The amount of subcutaneous fat over the abdomen was fairly good. There were scars of old operative interference over the right forearm. She had at 6 years of age in the Sick Children's Hospital, Edinburgh, a subperiosteal resection of the right radius with a bone-graft. This was done for tuberculous disease.

ON EXAMINATION.—*Abdomen*—no peristalsis noted. There was tenderness down the border of the right rectus almost into the right iliac fossa with the maximum tenderness just about the level of the umbilicus. There was the sensation of the presence of an elongated swelling running vertically in the position of the ascending colon. No glands were palpable. *Cervical area*—small glands could be felt in the posterior triangles. *Chest*—no sign of active disease made out, but there was prolonged expiration at the left apex. *Systemic disturbances*—the pulse-rate was 90 to 100 at rest, and the evening temperature up to 99·4°. The diagnosis appeared to be one of tuberculous hyperplasia of the cæcum and ascending colon.

DIAGNOSIS.—The history of increasing pain in the abdomen, and constipation over a number of months, pointed to some form of chronic obstruction. The patient was very thin, and there was the feeling of a tumour-like mass over the region of the cæcum. A barium meal was given. No abnormality was noted in the stomach itself. At five hours the meal was traversing the ileocæcal valve and the head of

FIG. 176.—*Case* 2. Barium enema showing filling defects in ascending colon.

FIG. 177.—*Case* 2. Barium enema seven and a half hours after injection.

the column had reached the descending colon. The whole cæcum and ascending colon showed marked abnormality. The cæcum was drawn up. The ileocæcal loop was drawn out almost to a straight line. The cæcum was very narrow, the ascending colon also narrow, but there appeared some pouching as if there were areas of normal bowel in the ascending colon. Normal sacculation began at the hepatic flexure.

At a later date a barium enema was administered (*Figs.* 176, 177). This passed easily round to the cæcum and partly through the ileocæcal valve, confirming and showing more clearly the narrowed and irregular lumen of the ascending colon and cæcum. The limits of the irregularity seemed very sharply determined, for normal sacculation was seen at the hepatic flexure. A diagnosis of tuberculous hyperplasia involving the cæcum and ascending colon was confidently made.

OPERATION.—The patient was removed on Aug. 4, 1931, to the Royal Infirmary, Dundee, to the care of one of us (J. A.). The provisional diagnosis was corroborated, and on opening the abdomen by a right paramedian incision was fully confirmed.

The lower third of the ileum was found to show about twenty annular constrictions. These were healed tuberculous ulcerations which narrowed the lumen of the bowel considerably, but there was no thickening.

The cæcum and ascending colon were noted as almost solid in texture, and were stripped forwards and resected. The ileum was implanted into the lateral wall of normal transverse colon, while the proximal end of the transverse colon was invaginated and closed. The cavity was covered with peritoneum and the abdomen closed. The patient made an uninterrupted recovery and was discharged to the Sanatorium on Sept. 22. She had a somewhat irregular temperature but the bowel moved normally and she had no pain. To date (March 15, 1932) she has improved and is now gaining weight, while her systemic disturbance has almost ceased.

PATHOLOGY.—The cæcum and ascending colon were resected, and the disease ended abruptly at the hepatic flexure. The specimen showed a curious irregularity. There were two pouches of bowel about the size of half-a-crown which appeared normal, felt normal, and were quite pliable. Apart from that, the gut felt thick and inelastic. The appendix was embedded in fat and firmly fixed on to the cæcum, its walls were much thickened, and a thin serous fluid was present in its tip. The bowel felt turgid, mainly on account of the mass of mesenteric fat and glands drawn round it. The glands appeared almost to hang on to the wall of the gut. On opening the bowel there was about half an inch of fat around it, but the bowel wall itself was much less thickened than is usual in this type of lesion, a quarter of an inch being the greatest thickness encountered. The mucous membrane presented a curious rugose formation with many warty projections, much ulceration, and some thickening. Apart from the two areas where the mucous membrane seemed normal, the appearance of sacculation on the films, the bowel was simply a cylinder.

HISTOLOGY.—Professor Cappell reports: "The condition is frankly tuberculous, with ulceration and destruction of the mucosa in places, associated with massive round-celled infiltration. Tubercle follicles with caseation are present in the mucosa and submucosa, the latter being much thickened and fibrosed. Secondary infection of the ulcerated surfaces has, of course, occurred, and the surviving mucosa is slightly hypertrophic. The glands of the ileocæcal angle are slightly enlarged but show no caseation; microscopically they are the seat of chronic tubercle follicles in small numbers. Tubercle bacilli have not been demonstrated in the sections; this is hardly surprising in view of the chronic nature of the lesions."

BACTERIOLOGY.—No tubercle bacilli were found on examination of a crushed gland, and no gland had any caseous appearance; but guinea-pigs inoculated with crushed gland, and with crushed bowel wall, all became tuberculous. The isolation of the infecting virus was effected at Glenlomond, and also by Dr. A. Stanley Griffith, Cambridge, to whom were sent some small enlarged glands and a piece of rugose ulcerated bowel wall. The lesions in the guinea-pigs were not marked, but glands and spleen were found infected when the animals were killed. Growths of tubercle bacilli were obtained both at Glenlomond and at Cambridge, and these proved to be eugonic, growing well on glycerinated egg and producing large, heaped-up, wrinkled growths. Rabbits were inoculated with the virus to make sure that there was no bovine strain present. The appearances of the rabbits with minimal lesions were those commonly seen after inoculation with a human type tubercle bacillus.

Dr. Griffith was satisfied, as were we at Glenlomond, that the virus was an ordinary human type tubercle bacillus.

COMMENTARY.

There are some features in relation to this case which are unusual:—

1. The first one—the familial incidence of a somewhat similar condition—has already been commented on. Neither patient appeared to show any active pulmonary tuberculosis. The fact that the infecting virus was found to be a human type tubercle bacillus is of first importance. One would have expected to find the bovine type in these cases, but from our experience the

familial incidence is against its being bovine, and the two sisters came to light as suffering from hyperplastic tuberculous disease of the bowel at much the same age.

2. The second point of interest in these two cases is that there were evidences of other tuberculous lesions in both. While one must always look for other lesions due to tuberculosis, those who have had experience of this intestinal condition have commented on the fact that other lesions have not been found. Indeed, the common experience is that this intestinal hyperplasia is the sole tuberculous manifestation, and pulmonary lesions are never found. But both the cases here have shown tuberculous cervical adenitis. Indeed, *Case* 1 had an excision of tuberculous cervical glands at three years of age, and *Case* 2 had a resection of the right radius at six years of age. The presence of cervical glandular lesions in both is of much interest, and one would have expected a spread towards the lungs in both cases, but *Case* 2 is the only one where some slight spread seems to have taken place.

3. The third noteworthy feature was the finding of so many healed tuberculous ulcers in the ileum in *Case* 2. This raises the question of route of spread of the disease in this patient. Did the small bowel and the large bowel become infected at the same time, and how did the bowel become infected? Was such infection primary or secondary to a one-time active pulmonary lesion? Was there a familial source of infection? All these questions are difficult to answer. We have not been able to find an open case of pulmonary tuberculosis in the family, but the father is now in New Zealand, and it is stated he is not a fit subject, and may have been the infecting agent of his two daughters. We must remember that the child is a 'ground' animal, and human type tubercle bacilli carelessly deposited could readily be ingested by the 'ground' animal. Probably the healed ulcers in the ileum are not ulcers due to tubercle bacilli swallowed from a pulmonary lesion. There is not sufficient evidence of even old pulmonary disease to have allowed of this possibility. Primary infection of intestine can occur in the child and such lesions do heal and leave contracted areas. It is of course known that tubercle bacilli can pass through a mucous membrane without destruction of tissue, but primary ulceration in the child is common enough. We are inclined to the view that the starting-points of the lesions in small and large bowel were by the same infection. The lesions in the small intestine were healed, and in the large intestine proliferative, and this very proliferation is the evidence of healing, and at the same time the cause of the distressing symptoms.

4. The fourth unusual feature is the fact that the extent of the thickness of bowel wall is not as marked as is commonly the case in this condition, which may be in part due to the type of organism. While there is no proof —and indeed little to suggest—that the bovine type is less virulent than the human type to the human subject, yet it may be that the type of lesion produced by the human type is more a destructive than a proliferative one. At any rate, in those cases examined by us where the thickening of bowel wall was marked, the virus proved to be bovine type. Further observation on this subject is desirable. The question naturally also presents itself why this peculiar type of hyperplasia should arise at all. It has been suggested

that there may be some antecedent disease in the large intestine, but this seems to be quite unnecessary to explain the causation. The disease appears to us to be one due to lymphatic obstruction.

The lymphatic plexus of the large intestine is much less developed than that of the small intestine; and the drainage through the paracolic glands appears to give a lymph network which is much more easily obstructed than the lymph drainage of the small gut.

Mesenteric glands are very numerous and all of them at one time will not be blocked, and new lymphatic channels can readily be formed in the small bowel mesentery; but the case is different with the large intestine, where blockage of the few paracolic glands will result in lymphatic stasis and subsequently a thickening of bowel wall, with possibly a retrograde lymphatic flow and later some organization of the affected tissues.

In the case described all the paracolic glands were not noticeably enlarged, and the lymphatic obstruction was not complete. The abrupt end to the extent of the disease in these cases appears to be entirely dependent on the extent of lymphatic obstruction.

SUMMARY.

1. A case of tuberculous hyperplasia is described.

2. The diagnosis was confirmed by X-ray examination after a barium meal.

3. The infecting virus proved to be a human type bacillus.

4. Certain features unusual in this condition, as well as the possible causation of the hyperplasia itself, are considered.

We wish to express our indebtedness to Professor Cappell for his investigation and report on the tissues, and to Dr. A. Stanley Griffith for his confirmation of the type of bacillus.

A METHOD FOR THE PRODUCTION OF INCREASED COMPRESSION STRENGTH OF BONE: AN EXPERIMENTAL STUDY (PRELIMINARY REPORT).*

By DUDLEY ROSS,

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Dr. Edward Archibald, of the Royal Victoria Hospital, Montreal, in 1924, proceeding upon the assumptions that in cases of fragilitas ossium (1) union nearly always occurs and therefore calcium metabolism is not at fault, and that (2) succeeding fractures rarely occur at the site of former ones and therefore bony union has strengthened the bone, carried out in one such patient an operation similar to that of Barth's,[1] although unaware of Barth's work. The latter in 1908 had removed longitudinal sections from the long bones in a case of juvenile osteomalacia, ground these sections into dust, and replaced the dust in the space from which the bone had been removed. In his report of the case he states that no further fractures occurred. Dr. Archibald's operation differed only in that the removed bone section was rongeured into small fragments instead of being ground into dust. These sections were placed in the medullary canal and the periosteum sutured over them. By this procedure he hoped that the bones would be strengthened, and the tendency toward repeated fractures lessened.

It is true that the fact that subsequent fractures do not occur at the site of previous ones is reported in the literature in several instances where cases were observed over a long period, but the reporters making these statements do not say how they arrived at this conclusion. As a matter of fact, the disease being one of childhood, it is difficult to state, on account of the growth in length of the bones, exactly where fresh fractures occur in respect of the site of a previous fracture. At two subsequent operations in Dr. Archibald's case, performed in 1928 on account of the occurrence of fresh fractures, small metal markers were inserted at the extremities of the opening left by the removal of the bony segment. In 1929 this patient suffered recurring fractures of both bones between the markers. A further attempt to increase bone strength was then made by doing the same operation on the opposite side to that of the first operation, in this case on the tibia, with the result that it gradually became clear that some better means of increasing bone strength had to be found if these cases of fragilitas ossium were to be helped, and the writer, at the suggestion of Dr. Archibald, began in 1929 an experimental investigation along these lines.

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* Read before a meeting of the Halsted Club, held at the Royal Victoria Hospital, Montreal, in May, 1931. Submitted for publication in March, 1932.

It was decided first to investigate experimentally the effect of the above operation on the compression strength of long bones of dogs, and on consulting with Dean Ernest Brown, of the Science Department, McGill University, the following method was evolved. After operation the bones were tested at various intervals in the testing laboratory of McGill University, and for this purpose a small Olsen testing machine of 10,000 lb. capacity was used. This

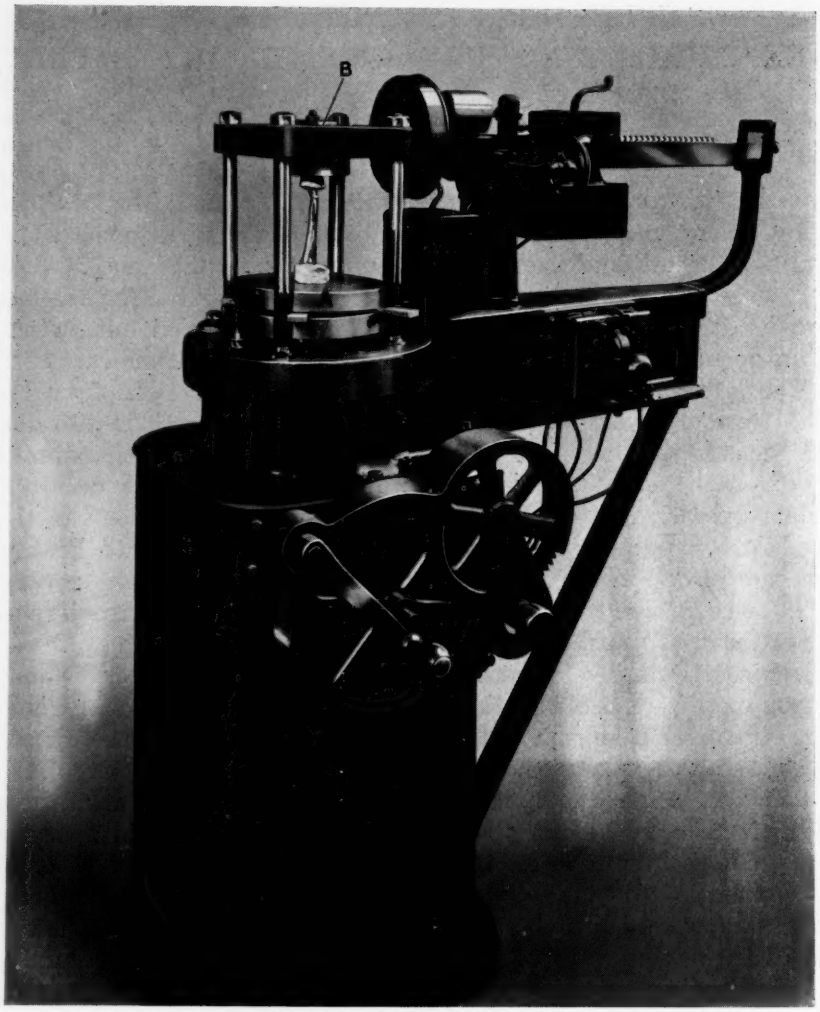


FIG. 178.—Bone mounted and in position for testing.

machine (*Fig.* 178) enables the bone to be loaded in compression, and a specimen arranged for testing is shown in the illustration. The ends of the bone were set in plaster-of-Paris contained in a ring of suitable diameter and depth, depending on the size of the specimen and the length of the bone operated upon. The plaster covered all the bone except that which had been operated upon. By this means it is believed that the load was distributed as uniformly as possible to the section under test, and that the results of such tests yield

reliable comparisons of the strength of the bone. The specimen shown in *Fig.* 178 is set up for the test, the two ends being embedded as described, and the bone being alined by eye so that its direction corresponded with that of the applied compression load. The specimen is set between a fixed base-plate A and a movable head B, the former corresponding to the platform of an ordinary weighing balance and being supported on a spherical joint which permits proper alinement. When a small initial load was carried and alinement secured, small wedges were inserted below A, to maintain the alinement. The load is applied by turning the gears shown in the foreground, thus rotating four vertical screws; this rotation pulls the head of B downward, and subjects the specimen to compressive load, the amount of which is determined by the position of a balanced weight on a horizontal lever shown at the upper right corner of *Fig.* 178. The lever is maintained in a floating position throughout the test, and the load carried is weighed as in an ordinary balance. When the load reaches a value at which the specimen begins to fail, the lever no longer floats, and the dropping of the lever indicates the beginning of failure. These are the loads recorded in this paper, and while larger loads are required to break the specimens, the loads at incipient failure form a proper basis for comparison of the compressive strength of such specimens.

Young adult dogs were used in all cases. The right or left lower hind leg was prepared for operation and the opposite leg was used for control. A longitudinal incision was made from the knee to the ankle over the anterior surface of the tibia, and the periosteum of the latter was then exposed and incised, the incision extending from cancellous bone above to the cancellous bone below. It was then carefully elevated and retracted with a sharp periosteal retractor, and two parallel cuts were made with an Albee saw through the cortex, these cuts being joined at either end. The segment thus outlined was removed and rongeured into small fragments and placed in the medullary cavity, the periosteum was then closed by interrupted catgut sutures, and the skin by interrupted silk. Following the operation the animals were kept on ordinary laboratory diet and no attempt was made to splint the leg operated on. When any bony infection developed the animal was discarded. Those that lived and showed no bone infection were killed at various periods ranging from ten weeks to six months after the operation. Both tibiæ were removed and denuded of all soft tissue and were immediately mounted for testing.

EXPERIMENTS.

Dog 1.—Young male adult. Subperiosteal resection of the left tibia. No post-operative complications. Ten weeks after the operation the animal was killed and the tibia removed. Grossly the bone appeared similar to that of the other leg.

Load capacity: Right tibia (control) 1130 lb.
Left tibia 560 lb.

Dog 2.—Young female. Subperiosteal resection of the left tibia. Three months after the operation the dog was killed and both tibiæ tested.

Load capacity: Right tibia (control) 866 lb.
Left tibia 558 lb.

Dog 3.—Young female. Subperiosteal resection of the left tibia. Animal killed five months after the operation. Both tibiæ were removed and subjected to load capacity.

Load capacity: Right tibia (control) 430 lb.
Left tibia 439 lb.

Dog 456.—Young adult dog. Subperiosteal resection of the right tibia. In this instance a piece of lead was placed in the medullary cavity, the rongeured fragments being laid on top of it. Four and a half months after the operation the animal was killed.

Load capacity: Right tibia 148 lb.
Left tibia (control) 143 lb.

These experiments go to show that the operation as described fails to increase the strength of the bone operated upon, and also indicates that the return to normal strength does not occur until at least four months after the operation. In other experiments chemicals, such as iodine, acriflavine, and iodoform emulsion, were placed in the medullary cavity without producing any increased strength.

Leriche and Policard[2] report one case in which they inserted a fleshy granulation graft into a bony cavity in the tibia, with the result that the cavity was filled with new bone. It occurred to us, therefore, that as ossification can take place in muscle it would be possible, by implanting an isolated muscle-graft in the medullary cavity, to increase the amount of bone, and by so doing increase the compression strength in the long bones of experimental animals. The following series of experiments was carried out. An isolated strip of muscle was taken from the tibialis anticus and implanted along the whole length of the medullary cavity subsequent to removing a section of bone according to the technique already described. The removed section was rongeured and the chips applied on top of the muscle, and the cut edges of the periosteum then brought into apposition. Following the operation the dogs were given the usual laboratory diet. No splinting was applied. Fifteen animals were operated upon in this manner, but only four lived and were satisfactory for testing, the rest either dying of distemper or being discarded owing to infection. These four were tested at various periods following the operation, according to the technique outlined previously.

EXPERIMENTS.

Dog 462.—Young adult dog. Subperiosteal resection of the right tibia. No post-operative complications. On the 74th day the animal met with an accident and had to be killed. The tibiæ were cleaned and disarticulated at both ends. Grossly their external appearances were the same. The circumference of the right tibia, however, was increased over that of the left by $\frac{1}{8}$ in.

Load capacity: Right tibia 490 lb.
Left tibia (control) 385 lb.

Dog 50.—Young adult dog. Subperiosteal resection of the left tibia. No post-operative complications. Bones tested 107 days after the operation.

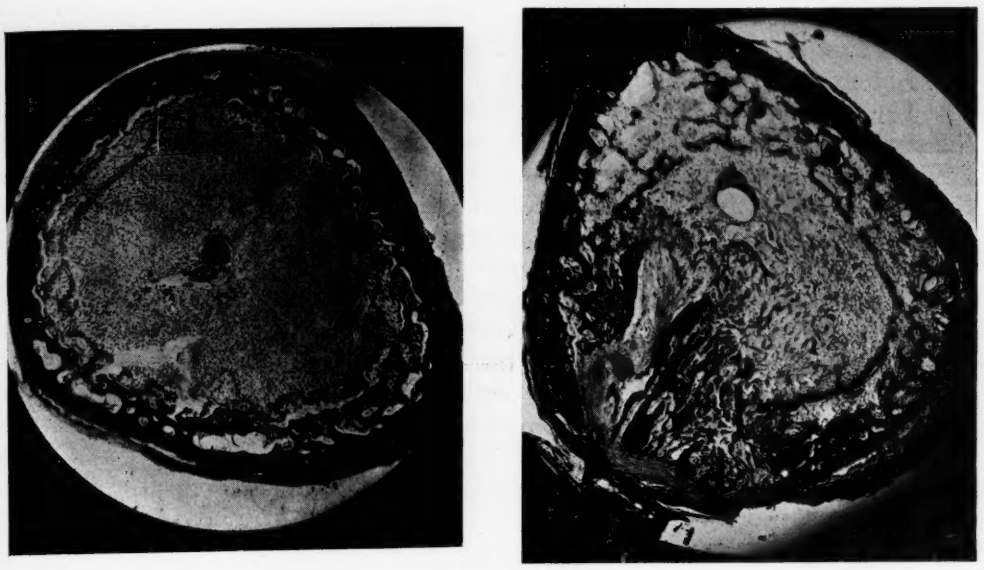
Load capacity: Right tibia (control) 138 lb.
Left tibia 290 lb.

Dog 33.—Young adult dog. Subperiosteal resection of the right tibia. No post-operative complications. Animal killed 147th day after operation.

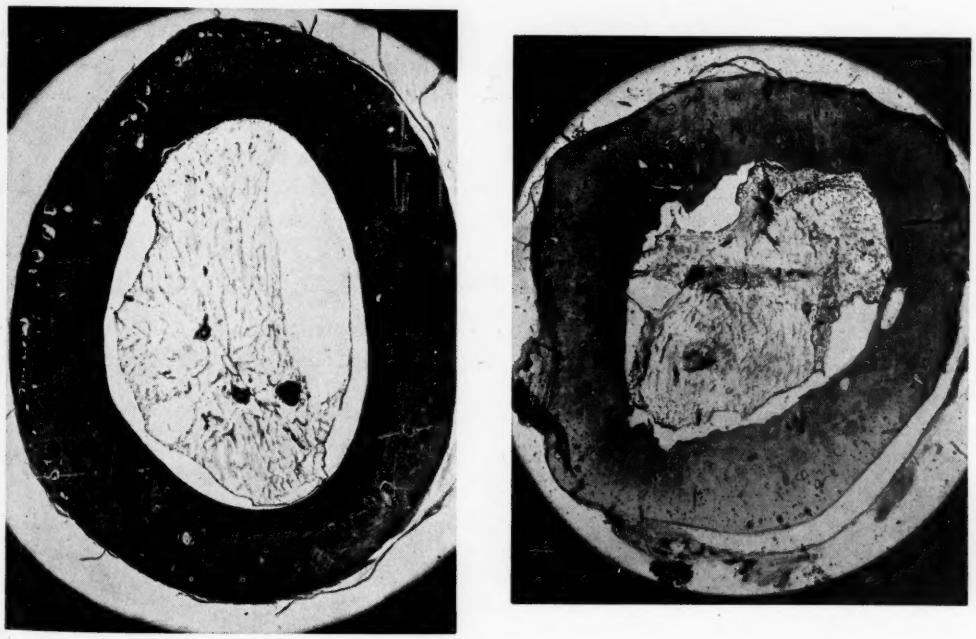
Load capacity: Right tibia 1041 lb.
Left tibia (control) 836 lb.

Dog 34.—Young adult dog. Subperiosteal resection of the left tibia. The animal was killed 193 days after the operation.

Load capacity: Right tibia (control) 623 lb.
Left tibia 654 lb.



FIGS. 179 and 180.—*Dog* 97. *Fig.* 179, Normal tibia. *Fig.* 180, Tibia 124 days after operation. The muscle has disappeared and has been replaced by fibrous tissue and new bone. The cortex is thickened and the circumference is visibly increased.



FIGS. 181 and 182.—*Dog* 92. *Fig.* 181, Normal tibia. *Fig.* 182, Tibia 148 days after operation. The muscle has disappeared. No evidence of the operation. The cortex is thickened. The irregularity of the cortex is due to collapse of the section at the time of cutting.

While this last animal showed smaller increase than the other three, it was felt that this may have been due to the fact that a very small piece of muscle was used in the transplant, and that therefore there was not as great a production of bone as in the other animals. As a result of these experiments four animals were operated upon in order to investigate histologically the changes that occurred in the transplanted muscle and the bone. They were killed at various periods ranging from 74 to 260 days after the operation.

The histological sections were taken transversely through the middle of the shaft, hardened in Zenker's fluid, decalcified, and stained with hæmotoxylin and eosin. In none of the sections was there any evidence of muscle tissue, this latter apparently having undergone transformation into fibrous tissue, which was replaced by bone. The sections all showed thickening of the cortex and an increase in circumference.

Fig. 180 shows the reproduction of new bone, particularly at the site of the operation, and the replacement of the muscle by fibrous tissue and new bone. *Fig.* 179 is the normal tibia taken through the same site as *Fig.* 180. *Fig.* 182 shows the muscle to have entirely disappeared. The cortex of the tibia operated upon is thicker, as can be seen by comparing it with the normal (*Fig.* 181), and the site of operation is not visible as it is in *Fig.* 180. The appearance of the remainder of the sections corresponds to that of *Fig.* 182.

CONCLUSIONS.

1. Isolated muscle-grafts, inserted in the medullary cavity of the bone, disappear and are replaced by fibrous tissue and ultimately by new bone.
2. The increase in new bone increases the compression strength.
3. While it is generally assumed that the interposition of muscle between fractured bones prevents union, it would seem from the above experiments, that, providing the circulation to that particular section of muscle is cut off, union will occur in the usual time.

Acknowledgement is made to the Department of Histology, McGill University, for the preparation of the histological sections. The work was made possible partly by the scholarship donated by Mr. P. P. Cowans, and partly by the grant of the Rockefeller Foundation to the Department of Experimental Surgery, McGill University.

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[2] *The Normal and Pathological Physiology of Bone*, 1928, 199. St. Louis: The C. V. Mosby Company.

SHORT NOTES OF RARE OR OBSCURE CASES

MACRO-GENITO-SOMIA.

By D. M. SUTHERLAND, Manchester.

Precocious sexual and bodily development (macro-genito-somia) may be associated with tumours of the suprarenal body, ovary, pineal gland, pituitary, or testis. Abnormal development associated with tumours of the testis is so rare that only two cases have been reported previously—one by Sacchi, of Genoa, in 1895, and the second by R. P. Rowlands in 1929 in the *Guy's Hospital Reports*. The rarity of the condition and the information which it may help to give on the internal secretion of the testis is the reason for the publication of the following case.

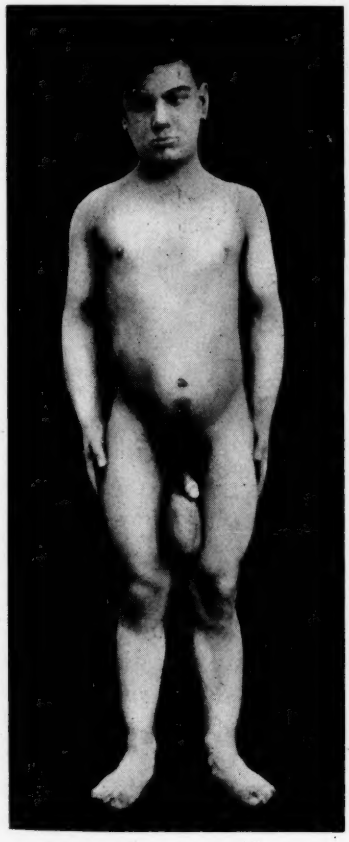

Fig. 183.—Photograph of patient.

Fig. 184.—Showing dilated scrotal blood-wessels.

A boy, aged 11 years, was seen by me in the out-patients' clinic of the Royal Manchester Childrens' Hospital in December, 1931, suffering from an

enlargement of the right testis. The boy was small in stature, but the secondary sexual characteristics were fully developed (*Fig.* 183). He was very muscular, looked much older than his true age, and was very intelligent.

On Examination.—The testis was found to be greatly enlarged and the scrotal veins were enormously dilated (*Fig.* 184). The testis was hard and sensitive to pressure. There was no obvious enlargement of the lumbar glands. The left testis was normal in size.

Radiological examination showed that all the epiphyses of the long bones had united. The pituitary fossa was not enlarged. The centre of ossification for the sternal end of the clavicle, which normally appears at 20 years of age and unites at 25, seemed to have almost united: it was possible to distinguish a thin line of separation between the epiphysis and the shaft.

Fig. 185.—Testis split along its anterior border.

I excised the testis in December, 1931 (*Fig.* 185). It measured about 4 in. in length and 3 in. in breadth. On naked-eye examination there did not appear to be any trace of normal testicular tissue or of the epididymis present. The testis was covered by an intact tunica vaginalis, not invaded by growth, but showing enormously dilated blood-vessels. The calibre of the spermatic artery was approximately that of the radial artery in an adult. The substance of the tumour was homogeneous reddish-brown in appearance and was partially divided by fibrous septa. There was one small area of hæmorrhage into the tumour.

Microscopical Examination of the tumour showed that the cells were indistinguishable from the normal interstitial cells of the testis. They

exhibited the same staining reactions and contained lipoid material. *Fig.* 186, stained by Mallory's method, shows the homogeneous nature of the tumour under low-power magnification. *Fig.* 187, stained with hæmatoxylin and

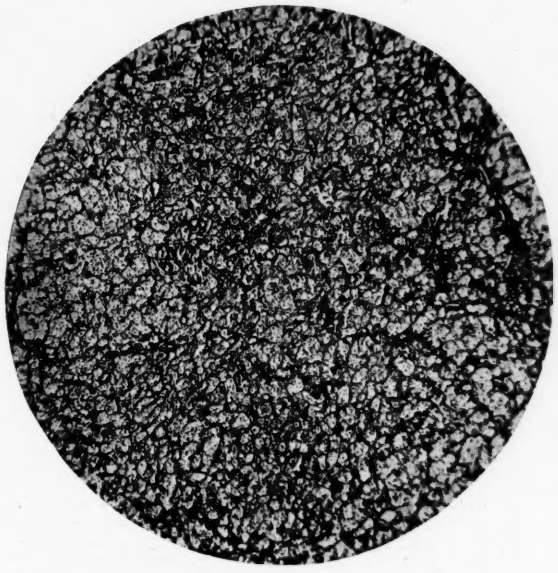

FIG. 186.—Section stained by Mallory's connective-tissue stain. (× 35.)

FIG. 187.—Section stained by hæmatoxylin and eosin. (× 250.)

eosin, shows the cells under high-power magnification: the clear spaces in the cells are the lipoid-bearing areas. There was no evidence microscopically of any of the cells of the tubules of the testis.

The history of the case suggests that the tumour was not malignant. The relatives of the boy stated that his premature development had been noticed by them four years previously, and said that the boy had been shaving since he was eight years old on account of his facial appearance.

SUMMARY.

A case is described in which overgrowth of the interstitial cells of the testis has caused premature normal development, and which appears to prove that the interstitial cells have an internal secretion influencing growth.

I am much indebted to Dr. Cooper, of the Anatomical Department of the University of Manchester, and to Dr. Somerford, of the Royal Manchester Childrens' Hospital, for their advice and help in the histology of the specimen.

A CASE OF PROPERITONEAL HYDROCELE.

By JOHN McDONALD HOLMES,

THE DEPARTMENT OF SURGERY, LEEDS UNIVERSITY.

The patient, a man aged 22, was admitted to hospital with a swelling of the left side of his scrotum of eighteen months' duration. Six months after he first noticed the scrotal swelling an abdominal tumour appeared in the suprapubic region. Both the scrotal and abdominal swellings enlarged painlessly until they reached the dimensions shown in the photographs (*Figs.* 188, 189).

On Examination.—A bilocular cystic swelling was found in the scrotum. The left inguinal canal was distended, and a cystic tumour was found lying deeply in the suprapubic region extending up to the level of the umbilicus. This abdominal cyst communicated with the scrotal swelling through the inguinal canal, for a definite fluctuating impulse could be obtained in the scrotum on pressing the abdominal tumour, and again in the abdomen on pressing the scrotum. The outline of the abdominal swelling did not entirely disappear when the patient made his abdominal muscles tense by raising his thorax from the bed. The scrotal swelling could be transilluminated well in its upper part, and less well in the lower part.

The communication between the scrotal and abdominal swellings through the inguinal canal was rendered more evident by injecting 2 oz. of a saturated solution of sodium iodide into the scrotal cyst, allowing a little time to elapse in order that the solution might diffuse, and then taking a skiagram of the scrotum and abdomen. The hydrocele was then partly evacuated by means of a trocar and cannula to prevent any symptoms which might have arisen from absorption of excess of sodium iodide. Seven pints of pale yellow fluid containing suspended cholesterol crystals were drawn off, and approximately two pints were left in the cyst at operation.

Operation.—The hydrocele was subsequently removed by Mr. J. F. Dobson, through a left inguinal incision. It was found to consist of three loculi, two in the scrotum, and one in the abdomen. The abdominal loculus

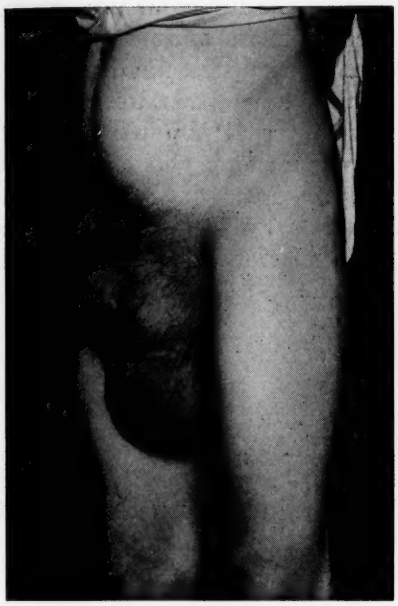

FIG. 188.—Semi-lateral view of the scrotum, showing the abdominal enlargement.

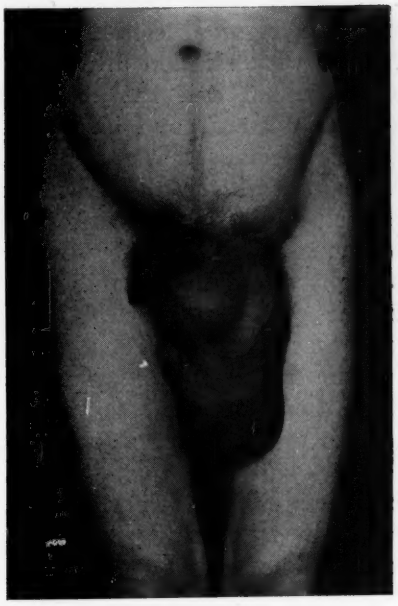

FIG. 189.—Anterior view of the hydrocele.

FIG. 190.—Skiagram after injecting the hydrocele with sodium iodide.

FIG. 191.—The entire hydrocele after removal, cut open to show the testis.

had evidently arisen from an unobliterated part of the funicular process lying within the inguinal canal. This unobliterated portion must have become distended with effusion after the scrotal sac had reached a moderate degree of enlargement, and the abdominal loculus must have been formed by its distension upwards and backwards through the internal inguinal ring. The abdominal loculus was found to be lying between the peritoneum and the anterior abdominal wall—that is, properitoneally. It was covered by a much thickened layer of subperitoneal connective tissue. The peritoneum was adherent to this layer over a small area at the upper end of the loculus, and was slightly torn in removing the hydrocele. The sac did not communicate with the general peritoneal cavity in any way. The obliterated funicular process was a short fibrous cord terminating in a small dimple as seen from inside the sac, and attached to the peritoneum at its upper end. The scrotal part of the hydrocele was very adherent to the scrotal tissues and cord, so the testis was included in the removal of the whole.

The small hole torn in the peritoneum was sutured, and the inguinal incision was closed as in a radical cure of an inguinal hernia ; first, by stitching the conjoined tendon to Poupart's ligament ; secondly, by joining the divided external oblique aponeurosis by means of imbricating sutures ; and lastly, by skin sutures.

The accompanying photographs (*Figs.* 188–191) show the patient as admitted to hospital, the skiagram taken after injection with sodium iodide, and the hydrocele after removal.

I am indebted to Professor J. F. Dobson for his kind permission to publish this case.

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SPINAL TUMOUR SEEN ON DIRECT X-RAY EXAMINATION WITHOUT LIPIODOL.

BY L. BATHE RAWLING,
SURGEON, ST. BARTHOLOMEW'S HOSPITAL, LONDON.

IN my own experience, and from inquiries amongst my neurological colleagues, it is most exceptional for a spinal tumour to be seen on direct X-ray examination without the aid of lipiodol. Hence the reporting of this case.

A man, age 40, was admitted under my care with a diagnosis of spinal tumour. The signs and symptoms were suggestive of a tumour lying outside the cord at the level of the 4th and 5th dorsal vertebræ. An X-ray was taken, and herein lies the main interest of the case. The tumour was clearly visible in the middle line as an oval swelling, the size and shape of an olive, at the level suspected (*Fig.* 192). Cisternal lipiodol sank to the upper level of the tumour, sitting on its upper end like a man in his saddle (*Fig.* 193).

Froin's syndrome was present, and it was clear that there was a more or less complete block.

The tumour was exposed and removed. It lay in the middle line, attached by one or two strands to the inner aspect of the dura, the cord

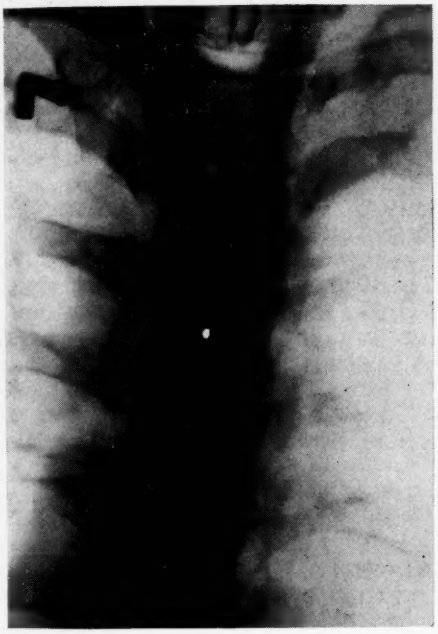

FIG. 192.—Showing the olive-shaped tumour in the middle line at the level of the 4th and 5th dorsal vertebræ.

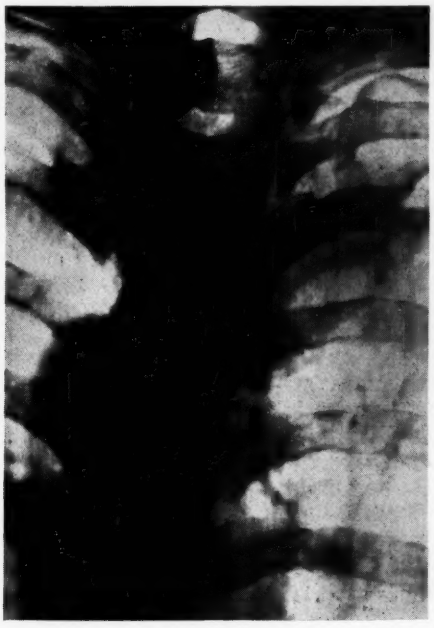

FIG. 193.—After cisternal injection of lipiodol.

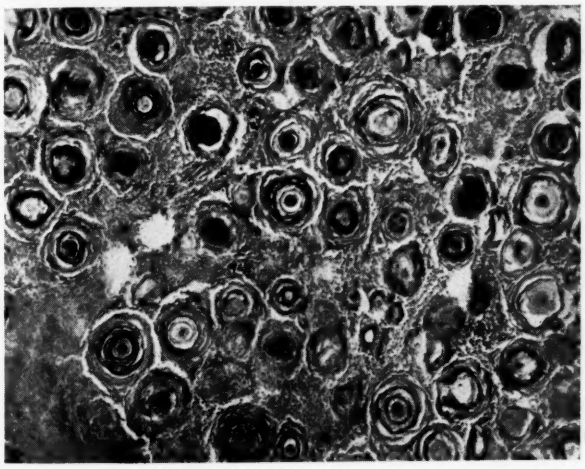

FIG. 194.—Microscopic structure of teratoma.

lying anterior and markedly compressed. No difficulty was experienced in its removal, and the patient is rapidly improving. The histology was that of a teratoma (*Fig.* 194).

REVIEWS AND NOTICES OF BOOKS.

Principles of Preoperative and Postoperative Treatment. By REGINALD ALEX CUTTING, M.D., C.M., M.A., Ph.D., Assistant Professor of Surgery, Louisiana State University Medical Centre. With a Foreword by RUDOLPH MATAS (New Orleans). Super royal 8vo. Pp. 812 + xx, with 76 illustrations. 1932. New York: Paul B. Hoeber, Inc. $10.00.

IT is very characteristic of present-day surgery that more and more attention is being devoted to the preparation of patients before operation and their management subsequently. This has meant the study of the physiological reactions of the body in health and disease and the application of such knowledge to surgical problems. How great the advance has been can be realized from the fact that nowadays a diabetic patient can be operated upon with scarcely any more risk than a normal patient. The complexion of the whole subject has been changed. This book differs from many such dealing with the same matter in that it attempts to expound the scientific basis for our present procedures. Thus the facts of water balance and dehydration are presented before a discussion of proctoclysis, infusion of saline, and hypodermoclysis.

A valuable chapter is that on disturbances of acid-base equilibrium, acidosis and alkalosis, in which the fundamentals of the subject, the properties of solutions, osmosis, pH, etc., are presented with great simplicity and clarity. Questions such as that of the administration of morphine, the control of gas pains, and vomiting are all carefully considered, and attempts are made to answer them in the light of known facts. The same method is employed all through, whether it be the management of urinary cases, thyrotoxic patients, head injuries, or post-operative lung complications.

We have nothing but praise for the book, which will be of interest to all surgeons, even those who have followed the literature of the subject; for the information is collected and the sources of it are given in an excellent bibliography appended to each chapter. There are a certain number of illustrations—as many as are necessary. The author's style is easy to read.

Surgical Errors and Safeguards. By MAX THOREK, M.D., Surgeon-in-Chief, the American Hospital, Chicago, etc. With a Foreword by ARTHUR DEAN BEVAN, M.D., Professor and Head of the Department of Surgery, Rush Medical College of the University of Chicago. Super royal 8vo. Pp. 696 + xiv, with 668 illustrations, many coloured. 1932. London: J. B. Lippincott Co. 45s. net.

IN his preface the author states: "While it is human to err, it is inhuman not to try, if possible, to protect those who entrust their lives into our hands from avoidable failures and danger. . . . Indeed, it is because of his own mistakes and the dangers which he himself has met that the author is filled with the keen desire to impress their possibility on others, so that they may benefit from his failures and disappointments." To achieve this laudable end the author has thoroughly searched the literature for recorded accidents and dangers and has, in addition, obtained the details of many unrecorded instances in the practice of colleagues and friends, while he relates unreservedly instances of his own personal shortcomings. As a result he has compiled what is probably the fullest account yet published of these surgical errors, and the only volume dealing with such that hails from America. In it are included errors in methods of examination, in diagnosis, in estimating the operative risks, in the pre- and post-operative care of patients, and in deciding upon the line of treatment, as well as the many errors and accidents that have actually happened during surgical operations. The lessons to be learned from these failures are appropriately

stressed, and many valuable practical points are presented from the author's great experience with a view to their prevention. The special difficulties and dangers associated with each region of the body are, in turn, fully considered—so fully, in fact, that it is not easy to conceive of many further mishaps than those here instanced that are ever likely to be met with. The volume will serve a most useful purpose if only it will tend to deter the undertaking of major operations by men relatively incompetent to perform them. While we can assure all progressive surgeons that they will find much of interest and profit in this volume, yet it is certainly one that should not be permitted to fall into lay hands.

Allgemeine und spezielle chirurgische Operationslehre. By Dr. MARTIN KIRSCHNER (Tübingen). Vol. II. Die Eingriffe in der Bauchhöhle. Royal 8vo. Pp. 574 + xii, with 395 illustrations. 1932. Berlin: Julius Springer. Paper covers, RM. 102; bound, RM. 108.

IT is difficult to describe this book in anything but terms of extravagant praise. The author, whom one would have thought exhausted by his share in editing the largest extant text-book of surgery, has now given proof of unabated vigour and skill. The present volume deals with abdominal surgery. The anatomy of the abdominal wall and all the methods of approaching the peritoneal cavity are clearly described, and then the general principles and the special details of all operations upon the stomach, intestines, biliary system, pancreas, and spleen follow and form the bulk of the book.

The outstanding feature of this work is the illustrations. We do not remember ever having seen anything so perfect in a surgical text-book. The remarkable feature about 395 coloured illustrations is the combination of exquisite artistic work both in drawing and reproduction with perfect accuracy of anatomical detail and clearness of diagrammatic presentation.

There is an ample recognition of mechanical aids to operative methods, and all sorts of contrivances from Murphy's button to Petz' sewing machine are included.

The description of operations is not confined to the formal procedures which can be carried out on the dead body, but include the real complications of disease—for example, the ulcers following gastro-enterostomy, the various types of paralytic ileus, and the pelvic and subphrenic abscesses which may follow appendicitis.

It is certainly a work that every medical library ought to possess, and it should afford a stimulus to British surgeons, artists, and publishers to produce a book of equal merit.

The Lame, the Halt, and the Blind. The Vital Rôle of Medicine in the History of Civilization. By HOWARD W. HAGGARD, M.D., Associate Professor of Applied Physiology, Yale University. Medium 8vo. Pp. 420 + xxvi, with 200 illustrations. 1932. London: William Heinemann (Medical Books) Ltd. 21s. net.

THIS book, written by the Associate Professor of Physiology in Yale University, belies its title. It is written for the American public and is a series of interesting essays under chapter headings the appropriateness of which is sometimes not apparent at first sight. Some of the essays are historical, some deal with old-world medical beliefs, whilst others are lay sermons upon the text that everyone should be thoroughly examined at least once a year with a view to the detection of the beginnings of disease. The advice may be good in theory, but in practice it would probably produce a race of neurasthenics. Amongst the subjects dealt with are the Black Death, rabies, the dancing mania, and tularæmia. There are some good short lives of Paracelsus and, as becomes a Professor of Physiology, of Dr. William Harvey and of William Beaumont, who elucidated the process of gastric digestion by his experiments on Alexis St. Martin.

The facts in the different essays are correct for the most part, but there is a good deal of embroidery which cannot be accepted as genuine. It was impossible, for instance, that Sir Walter Scott, who died in 1832, could have congratulated Sir James Y. Simpson, who received a baronetcy (not a knighthood) in 1866. Percivall Pott would certainly not have recognized himself as Dr. Pott, and Dr. Haggard's

republicanism has made him miss the point in his description of the King's Evil. Cures did take place as a result of, but not necessarily because of, the Royal Touch. The preliminaries were in reality a crude method of employing the open-air treatment of tuberculous glands. The patients often came from the most remote parts of the British Isles. The journey took weeks or even months and was made on foot or in slow wagons. The dark overcrowded cottages were thus left behind ; the food was entirely different, and a careful selection of suitable cases was made by the royal physicians before patients were admitted to the Presence. Then came a gorgeous ceremony followed by a second course of open-air treatment on the way home.

There are a few verbal slips which can easily be corrected, e.g., Cardimon for Cardamon ; Jacks for Jakes ; Melos for Melas. It may be noted, too, that no witch was burnt in Scotland in 1882, though a picture is given of the alleged burning. It was not worth while to revive the folk etymology of Monk's Bane for antimonium, as the word was in use at least 400 years before the reputed Basil Valentine.

Take it all in all, the book is worth reading and will pass away some holiday hours. It abounds in illustrations which are well reproduced and have been carefully chosen.

A Text-book of Neuro-Anatomy. By ALBERT KUNTZ, Ph.D., M.D., Professor of Micro-Anatomy in St. Louis University School of Medicine. Medium 8vo. Pp. 539 + xii, with 197 illustrations. 1931. Philadelphia : Lea & Febiger. $50.50 net.

MANY text-books on neuro-anatomy are available, but this recent one by Professor Kuntz can be heartily welcomed as a valuable addition because of its distinctive qualities. Whilst giving a very clear and concise account of the structure of the central nervous system, he has succeeded in advancing throughout the intimate relation which exists between form and function, and in correlating the " anatomical details with the fundamental structural plan of the vertebrate nervous system ".

The volume will be of service alike to students and to those who are qualified, since it includes a complete and up-to-date account of the structure of the brain and spinal cord, illuminated by knowledge derived from the study of phylogeny, ontogeny, and function. Reference is made to recent work upon such subjects as the diencephalon, autonomic nervous system, cortical cyto-architecture, and neuroglia.

Although the book contains a vast amount of detailed information, it is attractively written and stimulates the reader by the able way in which the significance of the facts is introduced and the origin and modification of different parts are explained. The text is freely illustrated by nearly two hundred excellent diagrams and photographs of sections, many of which are original, and at the end of each chapter is to be found a list of monographs and papers which have reference to matters discussed.

Professor Kuntz is to be congratulated on the production of a book the perusal of which will prove profitable to anyone interested in the nervous system.

Orthopædic Surgery. By WALTER MERCER, M.B., Ch.B., F.R.C.S.E., F.R.S.E., Assistant Surgeon, Royal Infirmary, Edinburgh, etc. With a Foreword by JOHN FRASER, *M.C.*, M.D., M.Ch., F.R.C.S.E., Regius Professor of Clinical Surgery in the University of Edinburgh. Medium 8vo. Pp. 695 + xii, with 371 illustrations. 1932. London : Edward Arnold & Co. 32s. 6d. net.

THIS is a very complete text-book compressed into a comparatively small space. The necessary condensation does not always make for easy reading, but on the other hand it renders the book essentially suitable for the student, who will find it simple to look up and read a brief account of any particular clinical condition, including its pathology, differential diagnosis, and the principles of treatment. Actual methods, mechanical and operative, are described quite shortly, sufficient for the student, but in many parts insufficient for those who intend to carry them out themselves. Any text-book of orthopædic surgery presents two essential difficulties : (1) That of arrangement, because it is almost impossible to classify the conditions that have to be dealt with entirely on either pathological or anatomical descriptions. The author has not made any real attempt to overcome this difficulty.

Whereas affections of the spine, shoulder-joint, knee-joint, and foot each have separate chapters, it is necessary to consult the index to find affections of the hip or elbow. (2) That in many lines of orthopædic work there are still great variations between different schools of treatment, and a book written in Edinburgh is almost certain to be criticized in London or in Liverpool. As an illustration of this we may instance the author's account of the different opinions on the treatment of congenital dislocation of the hip, in which he states that one school of treatment believes the hip should be reduced as soon after the age of $2\frac{1}{2}$ as possible, and, after quoting Galloway's view, says that a third group of workers would inaugurate treatment as early as possible. The last is surely the opinion that is almost universally held and taught.

An excellent feature of the book is the section given up to tumours of bone, which contains a careful and elaborate description based for the most part on recent American work. In spite of the great experience of these conditions which has been gained by the American Registry, it is still doubtful whether the nature of a tumour of bone can be diagnosed without a biopsy. Regarding the treatment of these tumours the usual pessimistic attitude about sarcomata has still to be taken, and no very definite line of treatment is put forward, although Kolodny's advice that the part should be treated by immobilization, radiation, and then amputation is mentioned.

The work is very well illustrated with radiographs, diagrams, and line drawings, and the arrangement of each section is sufficiently simple. There is a short list of references which does not attempt to be complete and which certainly leaves out a number that are really important. These references are arranged to correspond with the chapters of the book, and as a result it is impossible to find references to some of the subjects. To take the hip as an example, no references are given for coxa vara or osteo-arthritis of this joint.

The book should be a useful one for students reading either for a pass examination or for a higher standard, and also as a simple work of reference to the general practitioner.

Technique de l'Ostéosynthèse. By ROBERT DANIS, Professeur de Clinique chirurgicale à l'Université de Bruxelles. Royal 8vo. Pp. 162, with 149 illustrations. 1932. Paris: Masson et Cie. Fr. 55.

THIS monograph is devoted to a study of the technique of several types of osteosynthesis which may be applied to the treatment of fractures. The use of rustless steel wire, inserted through drill holes and not encircling the fragments, is strongly advocated in preference to most other forms of internal fixation. Numerous instruments and an ingenious adjustable operating-table are described and well illustrated.

As an exposition of the technique of osteosynthesis—and in particular of the use of the wire suture—this work is interesting; the consensus of surgical opinion, however, is that the operative procedures so enthusiastically defended by the author are very rarely necessary in the treatment of fractures at the present day.

Manipulative Surgery. By A. S. BLUNDELL BANKART, M.A., M.Ch. (Cantab.), F.R.C.S., Orthopædic Surgeon to the Middlesex Hospital, etc. Modern Surgical Monographs, edited by G. GORDON-TAYLOR, O.B.E., M.A., F.R.C.S. Demy 8vo. Pp. 150 + xii, with 21 illustrations. 1932. London: Constable & Co. Ltd. 7s. 6d. net.

MANIPULATIVE surgery is a valuable method of treatment, and it is kept prominently before the public largely because of the work of the unqualified practitioner and his methods of self-advertisement. This monograph, which deals briefly but very adequately with the subject, should be read not only by the specialist but by every practitioner of medicine. It is a personal statement of the views of the author on the uses and abuses of manipulation in surgery. It is dogmatic and is written with the simplicity and directness that would be expected from its author. In the introduction a brief account of anatomical, physiological, and pathological principles is first given, followed by a very short account of the methods and dangers of manipulations in general. The following sections deal in turn with the foot, the knee,

the hip, and other regions, the conditions amenable to treatment and the methods used being described in each case. There are some simple and clear photographs to illustrate methods. The book makes admirable reading and is full of valuable personal observations and opinions. The concise way in which important lessons are put may be illustrated by the opening sentence to the section on manipulation of the shoulder. "One of the most awkward situations in surgery arises when it has to be explained to a patient that his arm was broken while he was under an anæsthetic." There is a short chapter on bone-setting and osteopathy. On the latter Bankart is severe. "Osteopathy is a typical American money-making stunt." He advises inquirers to read the Bulletins of the A. T. Still Research Institute as a revelation of the way in which this subject can be written up in pseudo-scientific language for propaganda.

Allgemeine und spezielle Elektrochirurgie. By Dr. Med. HANS VON SEEMEN (Münich). Royal 8vo. Pp. 474 + xii, with 347 illustrations. 1932. Berlin: Julius Springer. Paper covers, RM. 62; bound, RM. 66.80.

IT would be idle to pretend that this book of 474 pages, interesting as it is, can be worth the 62 Reichsmarks (£4), which British readers (who of course pay Reparations excess) are asked to expend on it. Although 136 pages are devoted to apparatus, method of use, and the history of surgical diathermy in its various forms, it cannot be said that those who know nothing will receive simple instruction, or that those who are conversant with the electrotechnics of high-frequency apparatus will find anything very new.

The second or special part of the book is very lavishly illustrated, no doubt accounting for the high price. Many of the pictures illustrate surgical and pathological conditions as to which information would not be sought in a book on a technical method. To some extent this applies to the text also. At the same time, it is a demonstration that the cutting, coagulating, and hæmostatic currents can be applied in every field, from amputation of the limbs to excision of the upper jaw, from excision of the rectum to hæmangiomata.

The final section of the book, by Dr. Otto Schurch, deals with the combined employment of diathermy and irradiation, where there is, of course, a very wide field of utility. One of the advantages of diathermy undoubtedly is the diminution of sepsis in such situations as the mouth and rectum, when masses of growth are cleared out by the loop or by the flat coagulator. The authors say that after operation on rectal tumours, operable and inoperable, by diathermy, they have never seen either cellulitis or peritonitis.

The book, like all that come from Julius Springer, is beautifully produced, with very few printers' errors, and the translation of the well-known surgeon of St. Bartholomew's into the family of the bloody god Baal, may be only a tribute to his latter-day enthusiasm for the bloodless method of hæmostatic diathermy!

Die Formfehler und die plastischen Operationen der weiblichen Brust. By Dr. ERNA GLÄSMER, Frauenärztin in Heidelberg. Royal 8vo. Pp. 94, with 48 illustrations. 1930. Stuttgart: Ferdinand Enke. Paper covers, RM. 6.30; bound, RM. 7.65.

THOUGH plastic surgery has always featured prominently in the methods used by surgeons in this country in connection with certain deformities—for instance, in hare-lip—purely æsthetic surgery such as face-lifting and breast-moulding has had practically no position among the profession. What little has been practised has been carried on rather by the unorthodox practitioner. Foreign surgeons, on the other hand, have paid considerable attention to what is really one of the refinements of the art of surgery. For this reason British surgeons should welcome the appearance of the publication of this work by Dr. Erna Gläsmer, of Heidelberg. This small book of only 94 pages is an excellent exposition of all the most modern methods of breast-moulding and breast-lifting.

The operation in this country is practically confined to the correction of gross enlargements met with in parenchymatous hypertrophy, but apart from amputation

no text-book gives details of the procedure. The book contains not only details of the methods used to correct such gross deformity, but most of the methods employed to correct the ordinary pendulous breasts in women where sentiment or vanity—call it what you will—prompts this procedure. Practically the only method we have seen used in this country is the primitive one designed by von Lotsch, which sometimes gives good results. Needless to say, in order to attain anything like the precision required for success in these cases, great experience and constant practice are absolutely necessary. The results produced by the occasional performer are frequently anything but pleasing. The writer here can speak from experience. Besides these points the booklet deals with infantile breasts and the correction of depressed nipples. There are forty-eight excellent illustrations depicting different methods.

At the end of the book there is a list of 111 references to the literature of the subject, of which, however, only four are in French, one is in Spanish, and one is in English by an American and published in Germany. All the rest are German, which perhaps bears out what is said at the beginning of this criticism. The booklet is well worthy of the attention of those interested in the subject.

Die äusseren Abdominal-Hernien. By ERICH BUMM (Berlin). Imperial 8vo. Pp. 331 + vii, with 235 illustrations. 1931. Berlin and Vienna: Urban & Schwarzenberg. Paper covers, RM. 40.1; bound, RM. 42.50.

DR. BUMM states in his preface that the object of his book is to re-awaken and stimulate interest in the subject of hernia, which during the last ten years has fallen into disregard, although the cure of hernia is of the very greatest importance to so many human beings at the outset of their lives. This is certainly true; it may be doubted, however, whether Dr. Bumm's book will quite serve its intended purpose. It is a good account of the subject on conventional lines, but does not contain anything which arrests the attention or stimulates interest. The author's modesty seems to forbid the inclusion of any original observations, or even personal views as to the relative merits of the different forms of operation that are recognized. The really difficult problems, such as the treatment of direct inguinal hernia and of uncontrollable hernias in stout elderly people, are scarcely mentioned, so that the whole subject is left very much where it was ten years ago. The most important contribution to the problem of hernia made during the last decade has been Gallie's work on the proper use of fascial transplants, and this is not even mentioned in Dr. Bumm's book. The non-operative treatment of hernia is also completely ignored. The best feature of the work is the excellent series of illustrations. Many of these have simple colouring and are printed in the text, a method of illustration which is insufficiently used in this country. There is no index, either of subjects or of authorities—an unpardonable omission in a work which starts with the claim already quoted.

Division palatine: Anatomie—Chirurgie phonétique. By VICTOR VEAU, Chirurgien de l'Hôpital des Enfants assistés, with the collaboration of Mme. S. BOREL. Large 8vo. Pp. 568 + viii, with 786 illustrations. 1931. Paris: Masson et Cie. Fr. 140.

Traitement du Bec-de-lièvre unilatéral (Procédé du Dr. Veau). By PAUL PLÉSSIER, Ancien Interne des Hôpitaux de Paris. Large 8vo. Pp. 148 + iv, with 106 illustrations and 16 plates. 1931. Paris: Masson et Cie. Fr. 30.

ALTHOUGH the authorship of these two books is different, they are in reality complementary. The volume by Dr. Veau deals with cleft palate and its treatment, while the one appearing under the name of Dr. Pléssier, a former intern of Dr. Veau's, is essentially an account of his former chief's treatment of hare-lip. The name of Dr. Veau is well known in this country as an authority on these two important subjects, and the present publications are the outcome of experience gained in the treatment of over 500 cases of hare-lip and cleft palate.

The volume by Dr. Pléssier is perhaps the more formal of the two, and he reviews all the older methods of treatment of hare-lip and discusses the causes of failure.

All the technical details and steps in the operation as practised by Dr. Veau are described and illustrated.

Dr. Veau's volume on the treatment of cleft palate should be read by all who are interested therein. Not only is there a full discussion of the subject, but the details of some 500 case histories are appended and explained by a wealth of diagram and illustration. A valuable portion of the book is that contributed by Mme. Borel, who has been responsible for the after-training of patients operated on for cleft palate. There is in addition an analysis of 100 cases operated on between 1922 and 1926 and followed up. The author is to be congratulated on his presentation of a subject where accurate observation, careful surgical technique, re-education, and systematic follow-up are essential to any adequate exposition.

A Text-book of X-ray Therapeutics. By the late ROBERT KNOX, M.D., C.M. (Edin.), etc. Fourth edition, completed and edited by WALTER M. LEVITT, M.B. (Irel.), M.R.C.P. (Lond.), D.M.R.E. (Camb.), Medical Officer in Charge of the Radiotherapeutic Department, etc., St. Bartholomew's Hospital. Royal 8vo. Pp. 250 + xii, with 95 illustrations and 11 plates. 1932. London: A. and C. Black Ltd. 21s. net.

THE text-book of X-ray therapeutics by Robert Knox, completed and edited by Walter M. Levitt, is a worthy memorial to one of England's greatest radiologists. At the time of his death, Dr. Knox was engaged in the preparation of a new edition of his well-known book on radiotherapeutics. Owing to the lapse of time and the rapid advances in radiological methods of treatment, the task undertaken by Dr. Levitt must have presented many difficulties. These he has successfully overcome, and in the new edition, many chapters of which have been written entirely by Dr. Levitt, the whole subject of radiotherapy is fully dealt with in all its aspects.

After a brief introduction, the opening chapters deal with the effects of X rays on tissues, the physics of X-ray therapy, including X-ray measurements and apparatus, and with the principles of X-ray therapeutic technique. The physics are not too advanced for the average medical student, for which he will no doubt be thankful, and the principles governing the use of X rays in the treatment of disease are clearly and logically laid down.

Other chapters deal with the treatment of malignant disease and with diseases which affect the various anatomical systems. As an appendix there is a paper by the late Dr. Knox on " The biological factor as a guide to dosage and its influence upon the developments of technique ". A useful bibliography and an excellent index are provided. The illustrations are well chosen, and the publishers are to be congratulated on their part of the work. It is without doubt the best text-book on this subject which so far has been published in this country. It will be invaluable to students preparing for the Diploma in Radiology and to all radiologists who are practising this branch of the subject.

Primary Carcinoma of the Lung: Bronchiogenic Cancer: A Clinical and Pathological Study. By B. M. FRIED, M.D., Peter Bent Brigham Hospital, Boston, Mass. Royal 8vo. Pp. 247 + x, with 95 illustrations. 1932. London: Baillière, Tindall & Cox. 26s. 6d. net.

THE author states in the prefatory note that " clinician, pathologist and radiologist alike stress the frequent occurrence and significance " of primary carcinoma of the lung, and, were such necessary, this is the justification for the writing of this volume.

It is significant that the book is devoted entirely to the clinical and pathological aspects of the disease, and suggests that little or no attempt has been made to employ any form of active treatment other than X-ray therapy. Of this method of treatment in bronchiogenic carcinoma the author states it " may be dismissed by saying that its use has yielded no favourable results "—an opinion shared by the reviewer.

In the discussion on the incidence of pulmonary cancer the view is held that the increase of this disease is more apparent than real, and, further, that none of the suspected predisposing factors, such as influenza, tar inhalation, etc., can be said to be more than forms of pulmonary irritation.

The chapter on the histogenesis is of considerable interest, as the opinion is put forward that all primary pulmonary carcinoma is bronchiogenic in origin and results from excessive regeneration following irritation of the bronchial mucosa.

As only the basal cells are concerned in the process of regeneration, it is held that it is in these cells that the malignant process commences. Thus the squamous- and basal-celled epitheliomas of the lung do not arise from metaplasia of the superficial ciliated columnar epithelium but from protoplasia of the undifferentiated basal cells.

A feature of special surgical significance is the large proportion of cerebral metastases. In the group of forty-seven cases recorded in the monograph, no fewer than sixteen showed evidence of secondary deposits in the brain confirmed by operation or necropsy. Thirteen of these were diagnosed as 'tumour of the brain suspect'. Seven were operated upon as cerebral tumours without carcinoma of the lung being suspected or diagnosed until after operation.

This monograph shows evidence of wide study of the literature, careful analysis of the material supplied by a group of cases illustrating the protean manifestations of this disease, and, being clearly printed and well illustrated, can be heartily commended to all those who are interested in chest disease.

Die gesunde und kranke Wirbelsäule im Röntgenbild. By Prof. Dr. GEORG SCHMORL and Dr. med. HERBERT JUNGHANS. Large 8vo. Pp. 211 + xii, with 345 illustrations. 1932. Leipzig: Georg Thieme. Paper covers, M. 30; bound, M. 32.50.

THIS book is a study of normal and pathological anatomy of the spine in radiograms. It is therefore very important from the radiologist's point of view, as it is so necessary that he should know his anatomy and pathological anatomy thoroughly. The radiograms are all taken from pathological specimens, often from a sagittal section; in many instances the photograph of the pathological specimen is placed on one side of the page and the radiogram on the other. Thus, from the radiographic point of view, there are certain limitations, because a pathological specimen does not always give quite the same appearance as the living bone; in particular this would be noticeable in the case illustrating angioma of the vertebeæ (p. 76). Also it is never possible in the living being to obtain quite so sharply defined a radiogram when it is taken some distance from the vertebræ as one can get from a pathological specimen which can be laid directly on the film. Nevertheless the radiograms are a very good indication of what one is liable actually to see in the living subject. Most of the reproductions are either life-size or as near life-size as possible, many of them being three-quarters or four-fifths, and the amount of reduction, if it occurs, is almost always indicated in the corner of the picture. They are reproduced as positives, which is an advantage.

The work commences with a study of anatomical specimens of different parts of the vertebræ at various ages, and it shows clearly the development of the bodies of the vertebræ, but not so clearly that of the arches. After the bodies, arches, and articulations are studied, the intravertebral discs, ligaments, and spaces between the vertebræ are described. Congenital abnormalities are next treated in the same order, but the description of the various forms of spina bifida is reserved until later in the book.

The main portion of the book then deals with various diseases of the vertebræ, and in addition to common diseases many rare conditions are described with which fortunately the radiologist does not often come into contact. We would welcome a somewhat clearer account of osteoporosis, but this condition is still apparently the subject of research. In some cases the same may be said to apply to the description of some of the rarer conditions—for example, the Schmorl bodies first described by one of the authors. The commoner diseases and traumata are well illustrated and are described at length. The sacrum and the lumbo-sacral region are treated under a separate section from the rest of the diseases and injuries, though the reason for this is not apparent. There is an extensive bibliography at the end of the work.

The whole of the monograph is very full and complete. It is the more surprising,

therefore, that there is no index. This is, of course, a very great disadvantage in a book of reference, and in order to find some particular condition one may have to go through a large portion of the list of contents. There is no question, however, that notwithstanding this disadvantage it is a book which should be in the library of every radiologist and orthopædic surgeon as well as those general surgeons who are interested in this region.

Le Ascaridiosi chirurgiche. By Dott. ETTORE RUGGIERI. Medium 8vo. Pp. 256 + vi, with 29 illustrations. 1932. Lanciano: Giuseppe Carabba.

THIS is the first of a series of monographs to be published from the Surgical Clinic of the University of Parma. It runs to 250 pages, with a bibliography of 400 items, and sets forth all that is known about the *Ascaris lumbricoides* in its relation to man. There is an interesting account of the life-history of the worm, including the passage of the larva from the intestine to the liver, from the liver to the lung, and the arrival of the adult worm in the intestine via the bronchi, trachea, larynx, and pharynx. The experimental evidence of this cycle seems to be complete.

The pathological effects due to the worms are discussed under the heads of toxic and irritative action, mechanical, traumatic, infective, and what the author calls 'spoliative'—that is to say, in the diversion of foodstuffs. In the case of a single worm, this last is, of course, negligible; but since more than one hundred worms may be found in the intestines of a child, it might have some importance. To English readers it may be a surprise that intestinal obstruction by worms is quite common and occurs in several ways. Diagnosis of obstruction due to worms is difficult, unless the subject is known to be infected or unless radiography be called in aid.

There are sections devoted to invasions of the biliary and pancreatic tracts by worms, and accounts of occasional invasion of nose, ear, bladder, uterus, and other parts.

It appears to be doubtful whether the ascaris can penetrate the normal intestinal wall, but there is no doubt at all that it makes its way through a wall damaged by ulceration, or between stitches of a sutured intestine.

The book is very well printed and contains many illustrations, including a number of very interesting radiograms. It should prove valuable to all who practice where helminthiasis is common.

Edemi chirurgici. By Dott. OSVALDO AMOROSI. Medium 8vo. Pp. 228 + vi, with 28 illustrations. 1932. Lanciano: Giuseppe Carabba.

THIS monograph on the surgical œdemas, from the University of Parma, hardly attains the standard set by the first of the series. It is, in fact, not more than a compilation. It adds little or nothing to existing knowledge, and it is difficult to discern for what public it is written.

The early chapters deal with the characters of œdematous fluids and with the various theories of pathogenesis, mentioning all the well-known names. There are short paragraphs about various 'causes', but, for example, one under the heading 'hæmoclasic crises' adds nothing to existing knowledge of anaphylaxis. There are, of course, differences in the œdema associated with glanders and with anthrax respectively, but they are incidental rather than basic.

There is an interesting paragraph about dense traumatic œdema following on repeated injury, but whether it is worth while treating it by Mantelli's adaptation of 'Lampson Handley's' silk-thread operation seems doubtful.

Elephantiasis comes in for fairly copious illustration, but very little is said about the treatment of extreme tropical cases. Throughout the book, in fact, treatment is perfunctory, but that is inherent in the study of what, after all, is only a single feature, common to almost every surgical malady.

There is a section on œdema associated with neuritis, which might well have been made the subject of a monograph, but the present work is an example of rather unnecessary bookmaking. The illustrations are poor.

Das Pollersche Verfahren zum Abformen an Lebenden und Toten sowie an Gegenständen. By ALPHONS POLLER. Edited by E. B. POLLER and E. FETSCHER. With a Foreword by Prof. Dr. C. VON ECONOMO (Vienna). Large 8vo. Pp. 216 + xii, with 129 illustrations. 1931. Berlin and Vienna: Urban & Schwarzenberg. Paper covers, RM. 12; bound, RM. 14.

THIS is a description of a method of taking casts of the living body or pathological specimens. The material for the mould is a substance called 'Negocoll', which becomes soft when warmed to a little above body temperature. When set it possesses great elasticity, so that overhanging and undercut moulds can be taken. This means few instead of many sections. Some very remarkable examples of casts are shown in photographs, such as clasped hands and faces which bear even the most minute skin creases. It is actually possible to paint Necocoll on to the surface of the cornea after cocainization. It is certainly a very important technical advance in the production of casts.

Some Radium Cases at the Middlesex Hospital: A Photographic Record. By A. CAMERON MACLEOD, M.B., B.S. (Lond.), F.R.C.S., Late Surgical Registrar, Middlesex Hospital. Large 8vo. Pp. 154 + viii, with 122 illustrations. 1931. London: John Murray. 7s. 6d. net.

THIS book is primarily a photographic record of patients suffering from various forms of malignant disease who have been treated with radium at the Middlesex Hospital. It does not pretend to be a statistical review, nor a serious text-book of radiotherapy. It consists of a number of photographs of patients before and after treatment with radium, and is intended to convince the sceptic that radium is of some value in the treatment of malignant disease.

Collected Papers of the Mayo Clinic and the Mayo Foundation. Edited by Mrs. MAUD H. MELLISH-WILSON, RICHARD M. HEWITT, M.A., M.D., and MILDRED A. FELKER, B.S. Vol. XXII, 1930. Medium 8vo. Pp. 1125, with 234 illustrations. 1931. Philadelphia and London: W. B. Saunders Co. 60s. net.

WE note that the steadily increasing output of the Mayo Clinic has necessitated a further addition to the editorial staff: the newcomer is fortunate to have the privilege of being trained by one who has done so much for the standardization of medical terms and editorial methods as has the lady known to most of us for so many years as Mrs. Mellish, now Mrs. Wilson. In the present volume the policy of the last few years has been extended. Of 482 papers available for publication only one-sixth are reprinted in full, 30 are abridged, 55 are extracted, and the rest are mentioned only by title.

Judd, Matson, and Mahorner contribute a valuable paper on 'Pancreatic Cysts' with further records of 47 cases. These supplement Judd's paper of 1921 based on records of 41 cases from the Mayo Clinic, which soon became established as one of the classical papers of reference on the subject. The soundness of the conclusions which Judd arrived at in his original paper is shown by the fact that ten years further clinical experience has not demanded that any of these should be amended or reversed.

The contributions by James R. Learmonth, either alone or in association with others, on "The Sympathetic Nervous System in relation to Surgery of the Colon," will probably attract more attention than any other paper in this volume. They attempt to carry the surgery of the sympathetic nervous system a stage further than the work of Royle in an attack upon the post-ganglionic fibres rather than upon the ganglia themselves. It is much to be hoped that this writer will further continue this work both in the physiological and in the clinical field.

A paper by James C. Mason on "Extra-Uterine Pregnancy," quoted in abstract, is just one of those which particularly illustrates the value of this publication; there can be no other writer who can claim to share with this author the advantage of possessing records of 471 cases observed in one Institution on which to base his conclusions.

Dr. Louis B. Wilson contributes an important résumé of the opportunities for the study of morbid anatomy in the United States and Canada which should be of value to anyone who is organizing a pathological department.

Reference has been made to only a few of the papers of surgical interest which are published in full and in abstract. From a study of the titles of papers mentioned only under this heading, it is clear that the importance and value of the output of the Mayo Clinic shows no signs of decreasing.

BOOK NOTICES.

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.]

Intracranial Suppuration. By E. MILES ATKINSON, M.B., B.S.(Lond.), F.R.C.S., Surgeon-in-Charge of the Ear and Throat Department, Royal United Hospital, Bath. Modern Treatment Series. Crown 8vo. Pp. 127. 1932. London: Jonathan Cape Ltd. 5s. net.

Recent Advances in Anæsthesia and Analgesia. By C. LANGTON HEWER, M.B., B.S. (Lond.), Anæsthetist and Demonstrator in Anæsthetics, St. Bartholomew's Hospital, etc. Large post 8vo. Pp. 187 + viii, with 64 illustrations. 1932. London: J. & A. Churchill. 12s. 6d. net.

Kosmetische Operationen. By DR. ERNST EITNER (Vienna). Royal 8vo. Pp. 131 + vi, with 129 illustrations. 1932. Vienna: Julius Springer. Paper covers, RM. 18; bound, RM. 19.60.

Beitrage zur Mund- und Kieferchirurgie. By Prof. DR. G. AXHAUSEN (Berlin). Part 2 of Deutsche Zahnheilkunde, edited by OTTO WALKHOFF (Berlin). Large 8vo. Pp. 117, with 128 illustrations. 1932. Leipzig: Georg Thieme.

A Shorter Surgery. By R. J. MCNEILL LOVE, M.B., B.S. (Lond.), F.R.C.S., Late Surgical First Assistant, London Hospital. Demy 8vo. Pp. 414 + viii, with 9 illustrations. 1932. London: H. K. Lewis & Co. Ltd. 16s. net.

Urology in Women. A Handbook of Urinary Diseases in the Female Sex. By E. CATHERINE LEWIS, M.S. (Lond.), F.R.C.S., Surgeon, Royal Free Hospital, London. Large 8vo. Pp. 76 + viii, with 21 plates and 4 illustrations in the text. 1932. London: Baillière, Tindall & Cox. 6s. net.

General Surgery. Edited by EVARTS A. GRAHAM, A.B., M.D., Professor of Surgery, Washington University School of Medicine. Practical Medicine Series. Crown 8vo. Pp. 804, with 173 illustrations in the text and 64 plates. 1932. Chicago: The Year Book Publishers. (London: H. K. Lewis & Co. Ltd.) $3.

Livre d'Or à l'Occasion du Jubilé de Vingt-cinq Ans d'Activité chirurgicale du Dr. Théodore Papayoannou. By Various Writers. Medium 8vo. Pp. 278 + xiv, with 110 illustrations. 1932. Naumburg-Saale: Lippert & Co.

The Melbourne Hospital Clinical Reports. Edited by S. O. COWEN, JULIAN SMITH, junr., et al. Vol. III. No. 1, June, 1932. Crown 4to. Pp. 58, illustrated. 1932. Melbourne: W. Ramsay (Surgical) Pty. Ltd. Annual subscription, 10s. 6d.; single numbers, 6s.

Minor Surgery of the Urinary Tract. By HERMON C. BUMPUS, junr., Ph.B., M.S. in Urology, F.A.C.S., Section on Urology, the Mayo Clinic. Medium 8vo. Pp. 124, with 57 illustrations. 1932. Philadelphia and London: W. B. Saunders Company. 15s. net.

Eloctrosurgery. By HOWARD A. KELLY, M.D., LL.D., F.A.C.S., and GRANT E. WARD, M.D., F.A.C.S. (Baltimore). Large 8vo. Pp. 305 + xxii, with 382 illustrations. 1932. Philadelphia and London: W. B. Saunders Company. 35s. net.

La Pratique chirurgicale illustrée. By VICTOR PAUCHET. Fasc. XVIII. Super royal 8vo. Pp. 264 + vi, with 189 illustrations. 1932. Paris: G. Doin et Cie. Fr. 65.

Surgery of the Chest. By GEORGE F. STRAUB, M.D., F.A.C.S. Royal 8vo. Pp. 475 + xviii, with 341 illustrations. 1932. London: Baillière, Tindall & Cox. 57s. net.

Verletzungen und Krankheiten der Kiefer. By Prof. Dr. GEORG PERTHES (Tübingen) and Prof. Dr. EDUARD BORCHERS (Aachen). Royal 8vo. Pp. 623 + xv, with 234 illustrations. 1932. Stuttgart: Ferdinand Enke. Paper covers, RM. 75; bound, RM. 78.